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PARTICULARS OF THE MARINE MONSTERS OCEANIC AND GREAT EASTERN.

Within a few days the magnificent new liner *Oceanic* of the White Star Line will arrive in New York on her maiden trip. In our issue of February last we published photographs showing the huge vessel before and after launching, and we now are enabled to present to our readers views of the new liner as she appeared shortly before leaving the yard of Harland & Wolff, Belfast, where she was built. When ready for her transatlantic voyage (commencing September 6) she will, of course, sit deeper in the water, but even at the light draught it will be observed that she is an uncommonly handsome vessel of the modern type, and really recalls the definition of Rudyard Kipling, who says: "The liner she's a lady." In the view off the port bow, which is our frontispiece, the shapeliness of the *Oceanic* is specially noticeable. Her stacks for instance, though really huge, being elliptical in section do not dwarf the vessel, an objectionable feature in bow views of the Cunarders, *Campania* and *Lucania*.

TWIN SCREW WHITE STAR LINER OCEANIC SHORTLY BEFORE LEAVING HER BUILDERS' HANDS.

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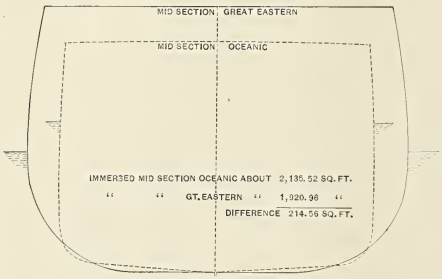
In connection with the dimensions of the *Oceanic* a comparison naturally is drawn, in the minds of those who follow the sea, with the famous *Great Eastern*. On page 95 we reproduce an original photograph of this deceased leviathan of the deep. At the time it was taken she had finished her career of real usefulness and was in use as a floating advertisement for an English storekeeper. An advantage in this fact for purposes of comparison is that she was light when the photograph was taken, the same condition as the *Oceanic* is here presented in.

In the issue before referred to we gave many particulars of the *Oceanic*, and now add some additional information in the shape of details, and we shall also here give a general description of the *Great Eastern*, so that an intelligent comparison of the vessels will be possible. Both were so huge that special problems in construction and launching presented themselves. Harland and Wolff, builders of the *Oceanic*, and in fact of all the White Star vessels, really anticipated the difficulties that they would encounter. As a first step the ground on which the vessel was to be built was piled and overlaid in part with boiler plate, and a cofferdam was built a considerable distance beyond high water mark—the vessel being laid down for an end on launch. The advantage of this was plainly seen when the cofferdam was removed for the launch, and the water came up fully one-quarter of the vessel's length, rising at the stern to the lower tips of the propeller blades. In this way she was fully waterborne much sooner than she would have been if built on ways in the usual manner. There was a depth of 36 ft. of water at the end of the lying ways, which went as far as the line of the cofferdam. The ways had a mean inclination of 1-2 in. per foot. When entering the water the *Oceanic* dipped to the 32 ft. mark.

At the beginning of building operations an immense traveling crane was erected over the ways, taking in 98 ft. in height and 95 ft. in width in the clear. The crane or gantry was chiefly for the purpose of handling the hydraulic riveting machines with which much of the erection work was accomplished. The aid of electrically driven drills was also employed extensively to ensure accurate work. A repetition here of the general dimensions will serve to recall the vast size of the structure. These are: Length over all, 704 ft.; between perpendiculars, 685 ft.; beam, 68 ft., and depth moulded, 49 ft. 6 in. When she was launched little of the machinery other than pumps and capstans was on board, and the launching weight was between 10,000 and 11,000 tons. The hull contains 17,000 steel plates of an average of 28 ft. in length, 4 ft. 6 in. in width, and from 1 in. to 1 3-8 in. in thickness, each weighing anywhere from two tons to three and a half tons. There were used in her construction about 1,700,000 steel rivets, some of which were 7 in. long and 1 3-8 in. thick. The frames are of channel steel, 9 in. deep with 4 in. and 4 1-2 in. flanges. She has a cellular double bottom the entire length about 5 ft. deep, increased to 7 ft. under the engine seatings. There are five steel decks, and in addition the usual promenade and boat decks. The hull contains thirteen 'thwartship watertight bulkheads, and one longitudinal bulkhead 97 ft. long separating the starboard from the port engine room. An outside bar keel 18 1-2 in. wide and 3 1-2 in. thick laid flatwise is rivetted through to the inside plate keel, which is 4 ft. 6 in. wide and 1 3-8 in. thick, laid in plates 30 ft. long.

A few secondary dimensions help to convey an idea of the magnitude of the vessel. The stern post with the inside brackets for carrying the stern tubes weighs 98 tons, the rudder complete weighs 53 tons, and the


MID SECTION GREAT EASTERN
MID SECTION OCEANIC
IMMERSED MID SECTION OCEANIC ABOUT 2,135.52 SQ. FT.
" " GT. EASTERN " 1,920.96 "
DIFFERENCE 214.56 SQ. FT.

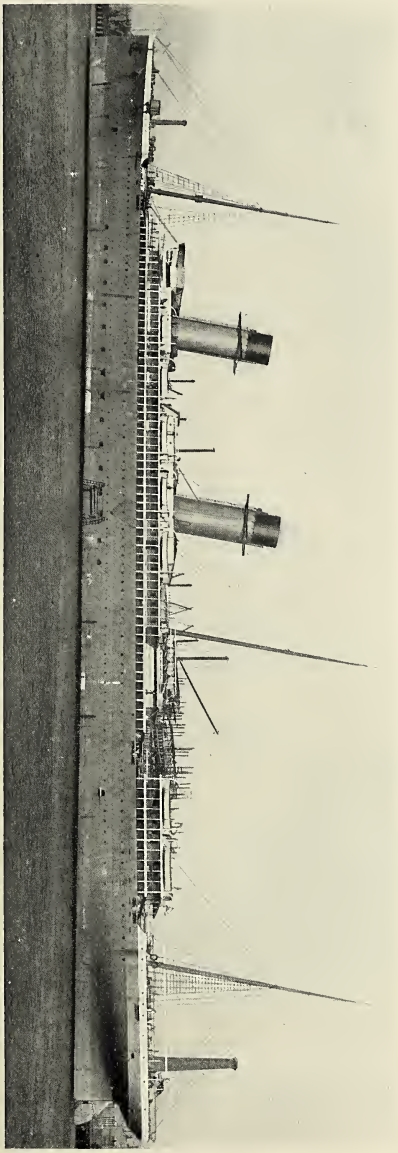
COMPARATIVE CROSS SECTIONS.

hawse pipes, made of steel castings, each weighs 7 tons. Her anchor cables are 3 1-4 in. bar, and the handling gear is, of course, heavy in proportion.

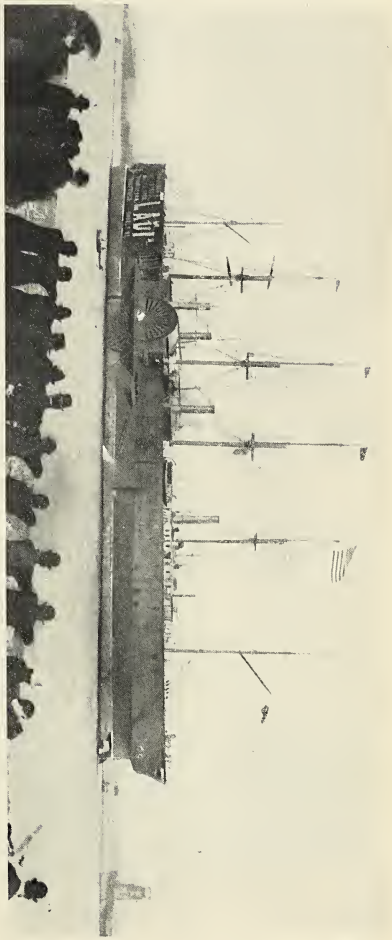
In common with modern practice the *Oceanic* is fitted with bilge keels for a length of 250 ft. on the sides, each keel being 18 in. deep. When fully loaded it is calculated she will draw 32 ft. 6 in. of water, and will displace 28,500 tons. If loaded to this depth she would not be able to come up on her dock at New York at low water, for there is then only 30 ft. in the ship channel. At mean high water this is increased to 34 ft. 6 in. which would give 2 ft. between the keel and the bottom.

The *Oceanic* has bunker capacity for 3,700 tons of coal, and if needed she could steam 23,400 miles, or around the world at 12 knots speed without recoaling. This is a point on which much emphasis was laid across the water when she was under construction. She is built to conform to the British Admiralty regulations for auxiliary cruisers, and in time of war she could be used to great advantage as a transport, steaming long distances without stoppage and carrying a great number of troops.

In her construction and equipment very great care has been taken to provide for all possible emergencies.



WHITE STAR TWIN SCREW TRANSATLANTIC LINER OCEANIC, THE LARGEST VESSEL IN THE WORLD BUILT OR BUILDING.



ORIGINAL PHOTOGRAPH OF THE LATE SCREW AND PADDLE STEAMSHIP GREAT EASTERN.

Not only are the main engines in duplicate, but a system of duplication has been adopted throughout, so that no ordinary breakdown or mishap could disable the ship. As a precautionary measure the rudderpost has been covered with a mass of white metal cast in place to prevent any serious corrosion which might be caused by galvanic action due to the use of bronze for the propeller blades. We have previously given the principal details of her main engines and boilers, but hope to give further particulars in a future issue.

Passenger accommodation on the *Oceanic* is naturally very extensive, and is provided for with all the ingenuity of resource that long experience in transatlantic travel can suggest. The main saloon is 80 ft. by 64 ft. and 9 ft. high in the clear, and there is a central dome 15 ft. dia. The room will accommodate 350 passengers at one sitting. There is accommodation for 410 first-class, 300 second-class and 1,000 third-class passengers. Some of the staterooms measure 13 ft. 6 in. by 9 ft. Beside the transients the vessel will carry 390 in the crew, and when filled, in the season, she will have on board 2,100 souls.

Though an unusually large job for a shipyard that makes a specialty of big work her construction was very expeditiously carried on. Her keel was laid in February, 1897, but the real work of hull construction was long delayed owing to delay in getting the traveling gantry, before referred to, in position. Most of the constructive work was done within about 12 months. She was launched January 14 of the present year. When she starts out from Liverpool she will represent an investment by the owners of about $5,000,000.

DESCRIPTION OF STEAMSHIP GREAT EASTERN.

In the year 1851 a corporation called the Eastern Steam Navigation Co. was formed in London for the purpose of operating an overland route between Great Britain, India, China and Australia. Failing to secure a Government contract for carrying mail, the company turned its energies to an all water route. The plan adopted contemplated the construction of vessels of large size, making the voyages out to central points of distribution, and the redistribution of freight and passengers by subsidiary lines in eastern waters. The company conferred with Isambard Kingdom Brunel, the famous English engineer, as to the possible construction of a great steamship, and he figured out a set of dimensions, etc. to meet the case. He was given authority to make contracts for the construction of the ship which was to be named the *Leviathan*. Mr. Brunel had already held consultations with J. Scott Russell, naval architect, and to the latter is due the credit for the lines and the practical construction of the vessel. The dimensions finally decided upon were: Length, over all, 692 ft.; length, between perpendiculars, 680 ft.; width of hull, 83 ft., width across paddle boxes, 118 ft.; depth moulded, 58 ft. She was to be propelled by side wheels and a single screw, and to have in addition sail power with a spread of 6,500 sq. yds. of canvas.

The contract for the hull and the paddle engines was given to Scott Russell & Co., of London, and for the screw engines to James Watt & Co., of Birmingham. Preparations were at once begun at Milwall on the Thames, where the ship was to be laid down. The soil consisted of a thick layer of mud on gravel, and, as in the case of the *Oceanic*, piles had to be driven to make a foundation. The ways were laid so that the ship was broadside to the water, chiefly for reasons connected with the practical construction of the vessel. One objection to an end on launch was the height to which it would be necessary to elevate the fore part of the vessel when building.

Iron was, of course, the material used for the hull of the new vessel. The plates used were about 10 ft. long by 2 ft. 9 in. wide and, for the outside, 3-4 in. thick, each weighing about 840 lbs. The framing was entirely longitudinal, the longitudinals being 2 ft. 10 in. deep and 1-2 in. thick, placed about 2 ft. 6 in. apart on the flat of the bottom, and from the bottom to a height of 26 ft. they were placed 5 ft. apart. The double bottom of the vessel (later christened *Great Eastern*) was carried up above the water line, and her upper deck was of cellular construction, consisting of longitudinal girders covered top and bottom by 1-2 in. plates. She was single rivetted throughout, except at the butts which were double rivetted. The largest size rivet used was 7-8 in., and all holes were punched. She had no outside bar keel, this being made of 1 in. plate. About 30,000 plates of an average weight of 600 lbs. were used in the construction of the vessel. Her launching weight was between 8,000 and 9,000 tons; the records varying on this as on many other points of her construction.

In the design great care had been taken in the light of existing knowledge for the safety and comfort of passengers. There were twelve watertight compartments below the lower deck, and nine above this deck. In addition there were two longitudinal bulkheads extending from the bottom to the upper deck and for a distance of about 350 ft. fore and aft. There was a space of 2 ft. 10 in. between the inner and outer skins, and this was subdivided into watertight spaces about 6 ft. square. The vessel was flush decked, there being only a few houses on the upper deck to obstruct the regular esplanade which this deck formed. There were four decks in all. A tremendously large space was available for passenger accommodation, the number which could be carried being: Saloon, 800; intermediate, 2,000, and steerage, 1,200. The main saloon was a fine apartment, 100 ft. by 36 ft. and 13 ft. high, and was lighted by skylights.

The propelling machinery was huge for its time, though it would not be considered specially so now except in comparing bulk with power. The paddle engines were simple, with four cylinders, each 74 in. dia. and 168 in. stroke, and when turning about 14 revolutions were expected to develop 3,500 I. H. P. Each cylinder, with piston and rod, weighed nearly 40 tons, and the crank shaft weighed about 30 tons. The screw engines were simple, horizontal, direct acting, with four cylinders, 84 in. dia. and 48 in. stroke, and turning at 55 revolutions were expected to develop 4,500 I. H. P. The cylinders were placed two on each side of the crank shaft with a platform between, and one of the most impressive sights on a ship fitted with many such view points was to stand on this platform and look up at the skylight above. It had something of the effect of looking up the elevator shaft of the modern skyscraper.

There were ten main boilers in all in the ship, those for the screw engines differing but little from those for

the paddle engines. They were of the double ended multitubular box type, built for a working pressure of 20 lbs. and were on the average in size: Length, 18 ft.; width, 17 ft. 6 in.; height, 14 ft., and weight 54 tons. There were 112 furnaces altogether, and the daily coal consumption at full speed was 400 tons. The coal bunkers were carried along the sides, and there was a total capacity of 12,000 tons, so that if need be the estimates—in fact the vessel in her uncompleted condition cost about $3,650,000. The resources of the company were exhausted and a new corporation was formed to complete the vessel at an additional cost of about $600,000. The original scheme to engage in the far eastern trade was then abandoned.

During the years '60 to '63 the vessel was engaged in the Atlantic trade. On her first trip West she

IMPORTANT VESSELS OF THE LEADING LINES NOW ENGAGED IN TRANSATLANTIC TRADE.

Line.	Name of Vessel.	Date.	Length Between Perps.		Breadth.		Depth.		Load Displacement.	I. H. P.	Sea Speed.
			Ft.	In.	Ft.	In.	Ft.	In.	Tons.		Knots.
	Great Eastern*.....	1858	680	0	83	0	58	9	27,000 (?)	8 000	13½ to 15
White Star.....	Oceanic.....	1899	685	0	68	0	49	6	28,500	28,000 (?)	20 (?)
Ham. Amer	Deutschland (bld'g).....	1899	662	6	67	6	44	0	23,000	35,000 (?)	23 (?)
Nor. Ger. Lloyd.....	Kaiser Wilhelm der Grosse.....	1898	625	0	66	0	43	0	19,684	27,000	22.25
Cunard.....	Lucania	1893	600	0	65	0	41	6	19,000	30,000	21.75
American.....	St. Paul.....	1896	535	0	63	0	42	0	16,000	20,500	21
French	La Touraine.....	1891	520	0	56	0	34	6	11,685	12,000	19.5
Anchor.....	City of Rome**.....	1881	560	0	52	0	37	0	12,000	11,000	17
Can. Pac.....	Empress of Japan†.....	1891	485	0	51	0	36	0	8,500	10,000	18.5
Dominion.....	New England	1898	550	0	59	3	40	0	20,000	8,700	16
Holland-America....	Statendam.....	1898	525	0	59	8	43	6	17,000	6,200	15

*Screw and Paddle. **Single Screw. †Trading Between Vancouver and Yokohama.

vessel could steam out to the East and home again without recoaling.

The side wheels of the vessel were 56 ft. extreme dia., each weighing in excess of 90 tons. There were 30 floats in each wheel, in size 13 ft. long and 3 ft. wide. The screw was 24 ft. dia. and 44 ft. pitch.

Work on the vessel commenced in the yard on May 1. 1854. and she was ready for launching November 3. started from Southampton, in the month of June, and after a passage of 11 days 2 hours she arrived at New York, having run 3,188 miles. This trip was made under rather unfavorable conditions. The firemen were green and did not keep up a good head of steam, and the above deck crew was new to the vessel. Then a good deal of time was lost through fog. The maximum speed on the trip was 14 1-2 knots, and the average, counting

DISTANT VIEW OF THE NEW TWIN SCREW WHITE STAR MAIL, PASSENGER AND CARGO STEAMSHIP OCEANIC.

1857. Two cradles had been provided to carry the vessel down the launching ways, the latter being about 300 ft. long and 120 ft. wide, and placed 120 ft. apart. The launch was a failure as the hull moved but 6 ft. and then stuck. Subsequently many attempts were made to get her into the water without success until January 31, 1858, when she was floated. The cost of these launching operations added enormously to the cost of the vessel which had already far exceeded the preliminary steam time, was about 13 knots. When she started from England her draught was: forward 22 ft. and aft 26 ft. During subsequent passages the *Great Eastern* met with several minor mishaps, tearing out part of her double bottom on one occasion on the Long Island coast, but at no time was she in serious danger. The Atlantic service did not prove profitable, however, and the big ship was taken off. Her subsequent services in laying the Atlantic cable are well known, and need

not be recounted here. After the completion of cable work the *Great Eastern* was laid up idle in Milford Haven. Many years afterward she was sold to an enterprising English retail merchant who used her for advertising purposes, and she visited various home ports. In the late eighties or early nineties she shared the fate of all vessels not lost at sea and was sold to a ship breaker to be reduced to scrap on the banks of the Mersey.

Institution of Naval Architects.

At Newcastle-on-Tyne, England, the summer session of the Institution of Naval Architecture was opened on July 18 last by the President, the Earl of Hopetoun. The opening was ceremoniously carried out, the Mayor of Newcastle and members of the Council forming a reception committee to give welcome to the assembled members. Those present included many of the leading British shipbuilders and engineers and several foreign guests. After the Mayor had welcomed the visitors the president delivered the opening address, touching upon the fact that the port was one of the oldest in the country, it having supplied a number of vessels to King Edward III's navy several centuries ago. At the session a number of important papers were read, which included: "The Rise and Progress of Rifled Naval Artillery," by Sir Andrew Noble; "The Distribution of Pressure Over the Bottom of a Ship in Dry Dock and Over the Dock Blocks," with special reference to the *Fulda* mishap, by Dr. Francis Elgar; "A New Method of Forced Draft," by Nelson Foley; "Elswick Cruisers," a descriptive paper, by Philip Watts, chief of the Armstrong shipbuilding plant; "Boiler Arrangements of Certain Recent Cruisers," by F. T. Marshall; "European Ice Breakers," a descriptive paper, which will be found reproduced in another portion of this issue, by H. F. Swan; "Nickel and Mild Steel Tubes for Water-Tube Boilers," by A. F. Yarrow; "Large Atlantic Cargo Steamers," by G. B. Hunter; and "Experiments on Thrust Block Friction," by F. Von Kodolitsch.

As the Tyne is a large shipbuilding center, an extensive programme of visits and social functions had been prepared. One of the most interesting visits was that paid to the immense works of Sir W. G. Armstrong, Whitworth & Co., Ltd., at Elswick, where luncheon was served. Among the vessels in course of construction, viewed by the visitors, were a Japanese battleship, two armored cruisers, two Norwegian armored vessels, and other war ships, including the U. S. cruiser *Albany*, which, it will be remembered, is a sister ship to the U. S. cruiser *New Orleans*, now in our service. The steel works also attracted a good deal of attention, and in the ordnance shops the manufacture of heavy cannon, from 12 in. downward, was examined in detail. Considerable amount of time was also spent in the engine works, where machinery for various vessels was under construction. The works of C. S. Swan & Hunter, at Wallsend-on-Tyne, were also visited, and among the vessels here viewed was a new cargo steamer for the Cunard line, 600 ft. long. The great shipbuilding sheds, 500 ft. in length, with glass roofs, were also viewed with interest by the visiting shipbuilders. Visits were also paid to Palmer Shipbuilding and Iron Co., Ltd., Jarrow-on-Tyne. These works cover nearly 100 acres, and have a water front of nearly 4,000 feet.

OUTLINE OF THE BRITISH NAVAL MANŒUVRES RECENTLY CONCLUDED.

British naval manœuvres for 1899 came to a practical conclusion on August 4 with the safe arrival of the fleet representing the "British" at its destination, Milford Haven, on the west coast of England, with the ships it had gone out to convoy. No vessels of the fleet representing the "hostiles" had been met with, and while the victory of the "British" fleet was complete it was technically bloodless. Mobilization for the manœuvres took place July 11, and hostilities commenced the last week in July.

The chief purpose of the manœuvres was to ascertain how best to employ a large number of cruisers in conjunction with a fleet having many vessels of the battleship class. It was also the purpose to gain information as to the relative advantages and disadvantages of speed vs. fighting capacity, and to get a line upon the effective handling of torpedo boats and destroyers. The opposing fleets were known as the "A" and "B" fleets, respectively. The official programme was as follows:

A British convoy "C" of slow ships escorted by a fast cruiser on passage from Halifax to Milford Haven is ordered to wait at a certain rendezvous the arrival of a protecting squadron.

N. B.—The slow ships cannot be taken in tow, must remain in company and have no fighting value.

A hostile squadron "A" of fast ships, lying at Belfast, is sent to sea to intercept and capture the convoy and bring it to Belfast. After an interval a superior British squadron "B" of slower ships is sent to protect the convoy "C" which has been ordered to a prearranged rendezvous, cover it from the hostile squadron, and bring it into Milford.

The whole of Ireland is "hostile" territory, and belongs to "A."

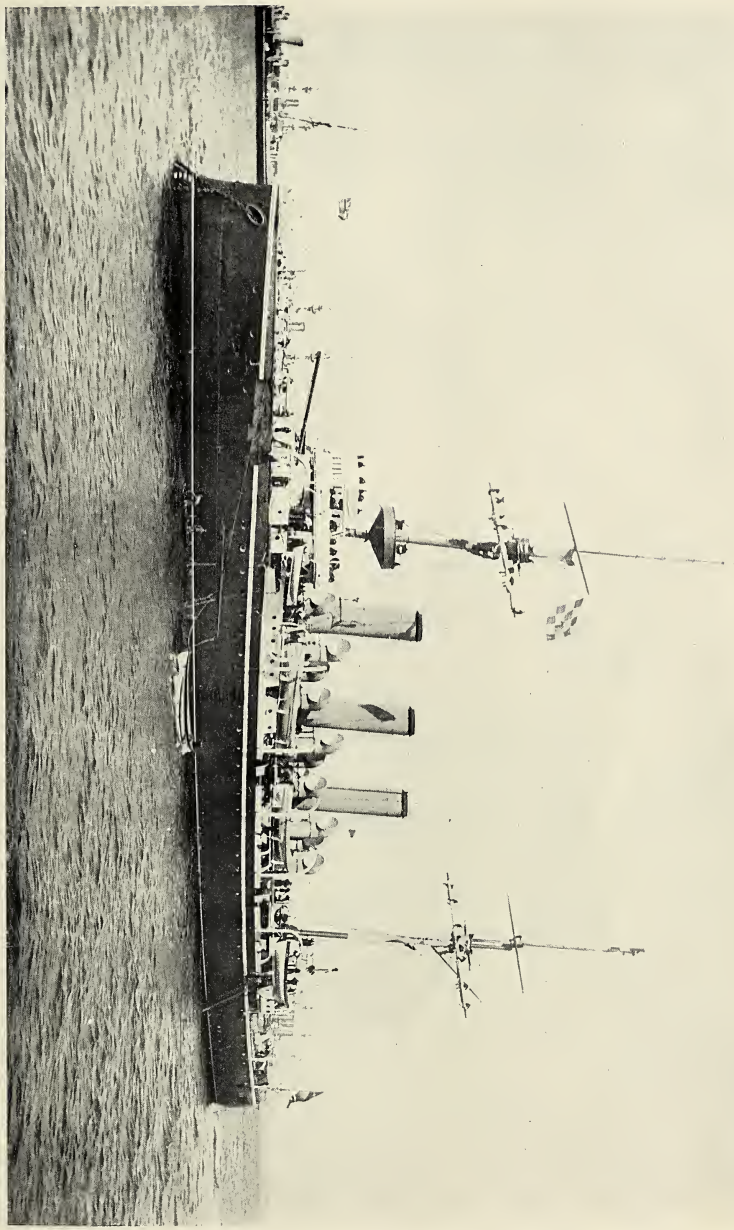
The coast of England and Wales from the island of Islay to the Lizard, including the Scillies and the Isle of Man, is "British" territory.

The hostile fleet "A" has torpedo boats at Waterford, Kingstown and Belfast.

The British fleet "B" has destroyers at Milford Haven, Holyhead and Lamlash.

The "A" fleet, under command of Vice-Admiral Sir Harry Rawson, with Rear-Admiral Arthur D. Fanshawe second in command, consisted of eight modern battleships, three first-class, fourteen second-class, and two third-class cruisers and twenty-four torpedo boats. The "B" fleet, commanded by Admiral Sir Compton Domville and Rear-Admiral Pelham Aldrich, second in command, was composed of ten battleships (some old), four first-class, sixteen second-class cruisers, and twenty-eight destroyers.

Admiral Domville, in command of "B" fleet, knew the exact spot where he would find the convoy (a point about 350 miles due west of Bantry Bay on the Irish coast), whereas Admiral Rawson had no exact information as to the point of juncture or the course to be subsequently taken. He had, of course, a knowledge of the general direction of the course taken by the convoy on its supposed westward voyage. The "A" fleet, though inferior to the "B" fleet in strength, was superior in the matter of speed, and was given a start of 19 hours, from Belfast, Ireland, ahead of "B" fleet, which went out from Milford Haven. The convoy, known as "C," consisted of the slow cruisers



BRITISH SECOND-CLASS CRUISER FURIOUS, 5,700 TONS, WHICH TOOK PART IN THE RECENT NAVAL MANŒUVRES.

Calliope and *Curacoa*. The "A," or hostile fleet, had the misfortune to run into a thick fog which lasted the greater part of two days, and to this is due, no doubt, some share of the success of the "B" fleet—whether such a fog would conveniently blanket a hostile fleet in time of genuine war is something that even the Admiralty experts cannot guess.

The "B" fleet on leaving Milford Haven took a course which would be least likely to bring it into contact with the enemy's ships, as the convoy was the objective point at this period of the operations of "B" fleet. The *Europa*, a powerful 20-knot cruiser, was sent ahead to connect with the convoy, and she was followed by the cruiser *Juno* at a considerable distance ahead of the fleet. Both these ships were fitted with the Marconi instruments for wireless telegraphy and the flagship of the "B" fleet was similarly provided with means of distant communication. Very great success attended this practical test of the apparatus. When the *Europa* reached the convoy the *Juno* was 55 miles distant, and yet the message announcing the connection made by the *Europa* was plainly received on the *Juno*, which vessel in turn passed the message along to the flagship, then 30 miles astern of the *Juno*. The distance of the fleet from the convoy when the messages was received will be more clearly appreciated when one learns that the message was received on board the flagship at 7.30 o'clock in the evening, and though the vessels of the fleet and convoy were then approaching each other at the rate of 21 knots, it was not until 11 o'clock the same night that they met. During the run out of the "B" fleet the *Juno* went ahead at a distance of about 10 miles and performed valuable service in signaling the presence of fog banks, fishing vessels, etc., so that long before the fleet met these each captain had been warned from the flagship what to look out for.

After a juncture with the convoy was effected by the "B" fleet, the course was shaped for Milford Haven, which was reached without contest. The speed was necessarily slow, as the best that one of the "B" fleet battleships—H. M. S. *Thunderer*—could do was between 11 and 12 knots.

There were several minor engagements between the torpedo boats of the "A" fleet and the destroyers of the "B" fleet, stationed at the Irish and English harbors, and in each case the destroyers claimed the victory.

A number of rules and regulations were, of course, laid down so that the commanders of the ships would have equal knowledge of the arbitrary offensive powers allotted to each class of vessel. All battleships engaged were to be considered of equal power, and the superiority of one battle squadron over another was to depend alone upon that which had the greater number of battleships. Other regulations provided that no cruiser of a lower class could count against a cruiser of a higher class, and that a torpedo fired at a ship had to be within a distance of 500 yards; and so on, covering all the chief points that would be likely to occasion serious dispute. One object of the Admiralty in this seemed to be the prevention of independent and desultory fighting and the concentration of effort on efficient scouting and fleet evolutions.

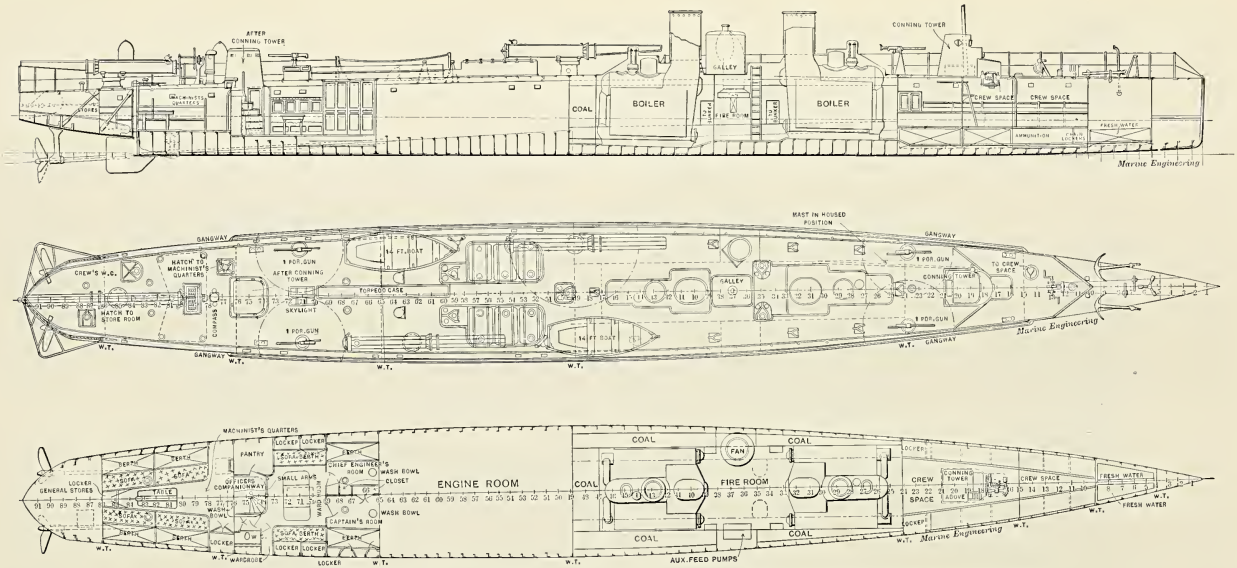
Among the modern vessels which comprised fleet "A" was H. M. S. *Furious*, a photograph of which, as she lay in the harbor of Belfast, the fleet's rendezvous, is reproduced on page 99. This new vessel is a typical modern British cruiser of the second class, and is the more interesting as she is almost directly comparable with the U. S. S. *Olympia*, now on the way home from Manila with Admiral Dewey. They are both twin screw protected cruisers. The *Olympia* is the older vessel, having first gone into commission February 5, 1895, while the *Furious* was put into commission on July 1, 1898. For the purposes of ready comparison we give the accompanying table, showing the chief characteristics of each.

COMPARISON OF THE BRITISH CRUISER "FURIOUS" WITH THE AMERICAN CRUISER "OLYMPIA."

VESSEL.	Length.	Beam.	Draught.	Displacement. Tons.	I. H. P.	Speed, Knots.	Normal Coal Supply.	Bunker Capacity.	Main Battery	Secondary Battery.	Torpedo Tubes.	Armor.	Complement.
H. M. S. *Furious*..	320 ft.	57 ft.	22 ft.	5,710	10,000	19.5	500	1,175	4 6-in. R. F. 6 4.7-in. R. F.	9 12-pounders. 3 3 pounders. 5 ½-in. Maxim	2	2 to 4.5 in.	450
U. S. S. *Olympia*..	340 ft.	53 ft.	21 ft. 6 in	5,870	17,300	21.6	400	1,169	4 8-in. B.F.R 10 5-in. R.F.	14 6-pounders 7 1-pounders. 2 Colts.	6	2 to 4.75 in.	450

As will be noticed in the photograph, H. M. S. *Furious* is fitted with three funnels, placed fore and aft, and with two masts with fighting tops. Her engines are vertical triple expansion, and she is fitted with Belleville water-tube boilers. With a total coal capacity of 1,175 tons she can steam 9,000 miles at 10 knots. The hull, which is sheathed, was constructed at the Royal Dockyard at Devenport, and the engines by an east coast private firm. Her conning tower is protected by 8 3-4 in. steel armor.

U. S. S. *Olympia* has triple expansion engines and Scotch boilers, and has, with her maximum amount of coal on board, a steaming endurance of 13,000 miles at 10 knots. She has two conning towers protected by 5 in. armor. In addition to her armor her bunkers are arranged for coal protection, and she has a belt of cocoa fiber at the water line. The big guns (four 8 in.) of the *Olympia* are placed in barbette turrets and protected by armor of a maximum thickness of 4 1-2 in. The cost of H. M. S. *Furious* is given as $1,403,860 and of U. S. S. *Olympia*, as $1,796,000. The *Olympia* was built and engined by the Union Iron Works, San Francisco, Cal. There are four cruisers in the British Navy of the same type as the cruiser *Furious*.



PLANS OF THE UNITED STATES TORPEDO BOATS DAHLGREN AND T. A. M. CRAVEN, BUILT UNDER A GUARANTEE OF 30 1-2 KNOTS SPEED.

NEW U. S. 30-KNOT TORPEDO BOATS DAHLGREN AND T. A. M. CRAVEN.

The construction of the United States torpedo-boats Nos. 9 and 10, since named *Dahlgren* and *T. A. M. Craven*, was authorized by Act of Congress passed June 10, 1896, and the contract for these vessels was awarded to the Bath Iron Works, of Bath, Me., on October 6, of the same year. The contract price for the hull and machinery (exclusive of ordnance equipment and outfit) was $194,000 each.

The principal dimensions of these interesting vessels are as follows:

Length over all	151	ft.	7 in.
" on L. W. L.	151	"	3 "
Beam Moulded	16	"	4 "
" over guards	16	"	11 "
Depth amidship side	9	"	4 "
" " center	10	"	0 "
Mean Draught	4	"	8 "
Draught aft under Propellers	8	"	9 "
" " " Rudder	6	"	11 "

The *Dahlgren* and *Craven*, although designed and built throughout by the Bath Iron Works, are of the "Normand" type. General T. W. Hyde, the president of the Bath Company, whilst in Europe three years ago, purchased from Mons. A. Normand, of Havre, France, a complete set of plans of the *Cyclone*, a 145-ton, 29-knot torpedo-boat, then building for the French Government, and these plans have guided the Bath yard and have proved of great value in working out problems both in original design and detail work. The guaranteed rate of speed of the *Dahlgren* and *Craven* is 30 1-2 knots, this speed to be maintained at sea for one hour.

No other shipbuilding firm in the world has as yet guaranteed this enormous speed on such a small displacement as 150 tons, but the builders are confident that these vessels will not only attain the high speed specified in the contract, but will make this speed and carry the required load of 20.29 tons, on a smaller displacement than that specified.

The steel hull of the *Dahlgren* (now completed) is acknowledged to be the lightest for its size ever constructed, and the machinery is likely to prove to be the lightest per I. H. P. as yet built in this country. The *Dahlgren* has a most pronounced hog sneer, with a much higher bow than the Normand boats possess. She has a square forefoot with strong U sections forward. There is a slight drag aft, and the deadwood stops at a point about 15 ft. forward of the aft perpendicular, forming the sternpost. Here a large balanced rudder is hung, 6 ft. long and about 4 ft. 6 in. deep. The midship frames are well rounded; the greatest beam is about 3 ft. above the load water line, and above this point there is a rapid tumble home. The shapes of the midship frames approach very nearly circular sections, thus giving great natural strength, and it is also well to note that the moment of inertia increases as the vessel is heeled; thus giving a higher metacenter when inclined than in the upright position. The water lines aft are very full, and the vessels have the usual Normand knuckle stern which has proved so efficient.

The frames are spaced 20 in. apart, except in the machinery spaces, where they are somewhat closer and located to suit the engines. There are eight water-tight bulkheads extending up to the main deck, besides a few non-watertight and the usual wing coal bunker bulkheads. The compartments in the forehold (in the hold forward of the boiler-room bulkhead below the lower deck) are used as chain lockers, and for the stowage of ammunition, torpedo war-heads; water tanks for the reserve feed water and fresh water for domestic purposes are also located here. All the available space in the aft hold is used for the stowage of ammunition. The stern of these vessels is of wrought steel, and the stern-post, rudder frame and shaft brackets, or struts, are of cast steel.

All the steel used in the construction of these vessels is high-grade steel galvanized. The steel before being galvanized had an ultimate tensile strength of 78,000 to 84,000 lb., with an elongation of 15 to 22 per cent. in 8 in., and an elastic limit of about 44,000 to 52,000 lb.

The crew is berthed on the lower deck forward. There are berths for twenty-four men, and the quarters are unusually roomy and comfortable for a racing machine. Just abaft the engine-room bulkheads are two large state-rooms, which together occupy the full width of the ship. The starboard room is for the commanding officer and the port room for the chief engineer. These rooms are complete in all their appointments. Just aft of them is the ward room, 7 ft. 6 in. by 16 ft. This room contains the usual mess table, lockers, etc., and two sofa berths. Aft of the ward room is the pantry, the officers' w. c. and the companionway which leads into the aft conning tower. Abaft the officers' quarters and separated from them by a steel watertight bulkhead are the machinists' quarters, 16 ft. 6 in. long and the full width of the boat. Here four berths and four sofa berths are located, also the usual folding table, lockers, lavatories, etc. The space aft of the machinists' quarters makes a most desirable general store room.

An aluminum alloy is used extensively on these boats. The galley, aft conning tower, cases for spare torpedoes, engine hatch covers, cowls, and all deck opening covers are made of this material, 7-64 in. thick. The main deck is covered with linoleum 5-32 in. thick, but a light wood grating in wood patterns will probably be fitted over the boilers on this deck.

Torpedo-boats of the *Dahlgren* class have two short, stumpy-looking smoke pipes. They are only 8 ft. 6 in. high above the deck—a few inches above the awnings—and are of elliptical section measuring about 4 ft. fore and aft and 3 ft. athwartships. The galley, made of aluminum, is located between the stacks. It is only 5 ft. long and 4 ft. wide, but a galley range, coal box, sink and dresser are contained in it. Abreast the galley is a large ventilator cowl about 3 ft. dia., which delivers air to the horizontal ventilating fan used for forced draft, and which is located in the fire room below.

There are two conning towers. The forward one is made of steel, bullet proof. It is of a peculiar shape, for the forward part contains the steering engine and wheel, the helmsman being below the level of the deck so that the lookout can see over his head. The Hyde steam windlass is located just forward of the conning tower. The steering engine is arranged to work the windlass in an ingenious manner. There is no turtle-back fitted on these boats, but a high breakwater runs diagonally aft from the forward side of the conning tower. The aft conning tower, or observation house, is made of aluminum, and, as before stated, forms the companionway to the officers' quarters. The hand steering wheel is placed in this tower.

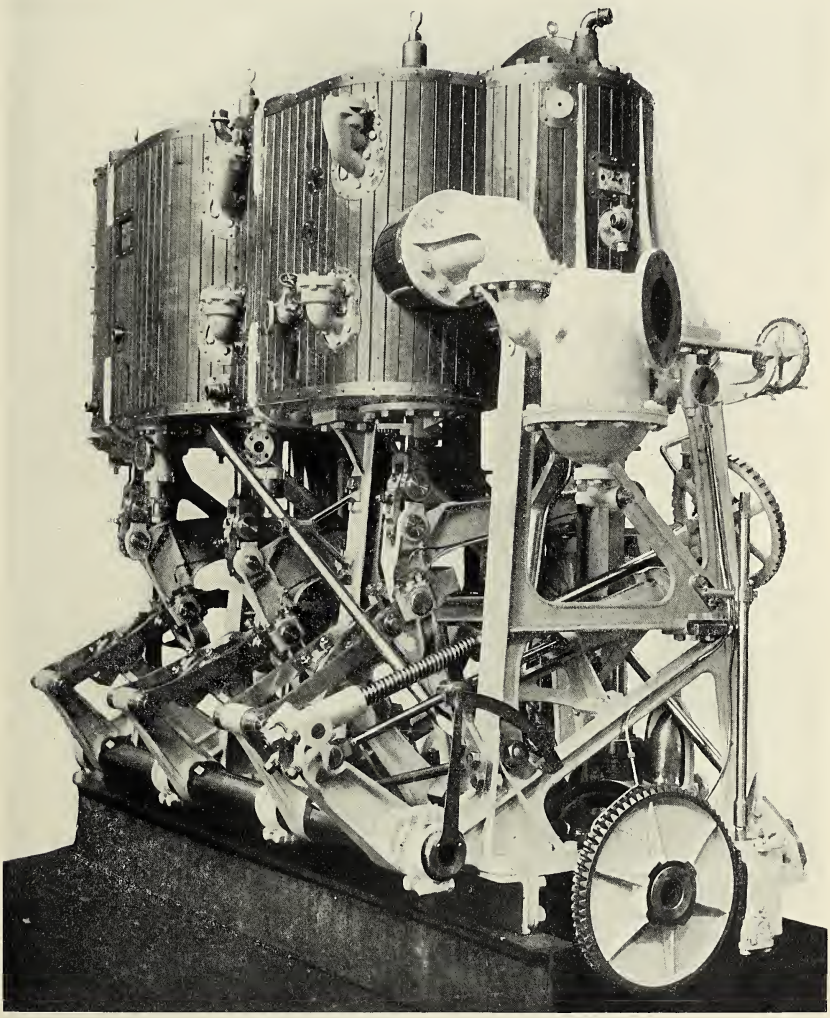
The boilers in these boats are the largest Normand boilers, and they project through the deck considerably, thus necessitating large boiler casings. The engine casings have also had to be made quite large, as the Normand engine is a short, wide engine, and the top of the cylinders on these boats come just about on a level with the deck.

The *Dahlgren* and her sister each carry two 14-ft. cedar boats and the usual U. S. Navy equipment for this class of vessels. They are fitted with two deck discharging tubes for 18-in. Whitehead automobile torpedoes, both of which are located in the center line of the vessel abaft the engine room casing, one being at the extreme aft end of the deck. They also carry a battery of four 1-pdr. rapid-fire guns, two forward and two aft. Coal bunkers are arranged on each side of the boilers, and between the engine and boilers is an athwartship coal bunker. The total bunker capacity is 32 tons, and at full power the consumption will be about 3 tons of coal per hour. About 7 tons of water will be carried in the tanks forward.

There are three large watertight hatches in the main deck with spring covers, which can be opened from either side, communicating with the engine room. Two more lead to the fire room, one leads to the machinists' quarters, one to the general store room aft, one to the crew's quarters, and two smaller hatches give easy access to the back of the boilers. The crew's space is also entered from the forward conning tower. The crew's w. c. is located on the main deck aft. The vessels are rigged with a hinging 30 ft. spar alongside the forward con-

ning tower, which will be used for signaling purposes. A wood fender is worked on the sides of these boats for about three-fourths of their length amidships.

As the propellers project beyond the sides of the boats large pipe propeller guards have been fitted aft, the width over these guards being about 15 ft. The *Dahlgren's* machinery consists of two vertical triple expansion engines driving twin screws. They have each three cylinders, the dia. being 17 1-4 in., 24 7-8 in. and 37 3-8 in., with a stroke of 21 in. The engines are arranged in a common watertight compartment, with the high pressure cylinders forward and the low pressure cylinders aft. The high and intermediate pressure cylinders are fitted with piston valves, and the low pressure cylinders



THREE CYLINDER TRIPLE-EXPANSION ENGINES OF THE U. S. TORPEDO BOAT DAHLGREN.

have a slide valve. These valves are operated by the Stephenson link motion. The engines are very compact, the fore and aft dimensions being reduced to a minimum, the valves being all placed on the side. The distance between centers of the high and low pressure cylinders is only 5 ft. 8 in., and the total height of the engine above the center of the shaft is only 8 ft. 6 in. The over-all length of the engine, including thrust bearing, is 11 ft. 6 in., the over-all width being 6 ft. Each engine is designed to indicate 2,100 I. H. P. at about 320 revolutions per minute, which is equivalent to a piston speed of 1,120 ft. per minute. Each engine is fitted with its own independent condenser, made entirely of sheet brass, of the usual torpedo-boat type; but in the vessels of the *Dahlgren* class great care has been taken with the arrangement of the scoops or inlet and outlet to the condensers. No circulating pump is necessary for ordinary running, as the speed of the boat forces the sea water through the condenser tubes. A small circulating pump is fitted, however, for use in dock trials, etc. The cooling surfaces of each condenser is 1,200 sq. ft., the shell of the condenser being 7 ft. long, of curved form, and 3 ft. 6 in. dia. The tubes are of Muntz metal, tinned, 5-8 in. dia. outside, and they are expanded at the ends into bronzed tube sheets 1 in. thick. The tubes are slightly curved to allow for expansion. Each engine has a single acting air pump, 13 1-4 in. dia. cylinder by 4 1-2 in. stroke, driven from the low pressure crosshead. Also two main feed pumps worked from the intermediate pressure crosshead. The shafts, piston rods, connecting rods, valve rods and working parts generally are of forged nickel steel. The high pressure pistons are made of cast iron, the intermediate pistons of cast steel and the low pressure pistons are of forged steel, the pistons being of equal weight. The bed plates are made of cast steel, and the framing is of Hyde manganese bronze. Each cylinder is steam jacketed. The cylinders are of close-grained cast iron, the barrels being about 3-4 in. thick. The crank, line, thrust and propeller shafts are of forged nickel steel, with a hole drilled axially through them. The crank shaft for each engine is in one section, 6 7-8 in. outside dia. The crank pins are 6 3-8 in. dia. and 11 3-8 in. long. There is a 3 3-8 in. hole bored axially through each crank shaft and a 3 in. hole through each crank pin. The thrust shaft is 6 1-4 in. dia., forged solid with the crank shaft; each shaft has eleven thrust collars. The propeller and line shafts are each in one section, 6 7-8 in. dia., with a 4 5-8 in. hole bored through.

The propellers are made of Hyde manganese bronze, the starboard wheel being right and the port wheel being left-handed. They are each 3-bladed, with a dia. of 6 ft. 6 in. and a pitch of about 12 ft. The blades have an inclined element of 6 in.

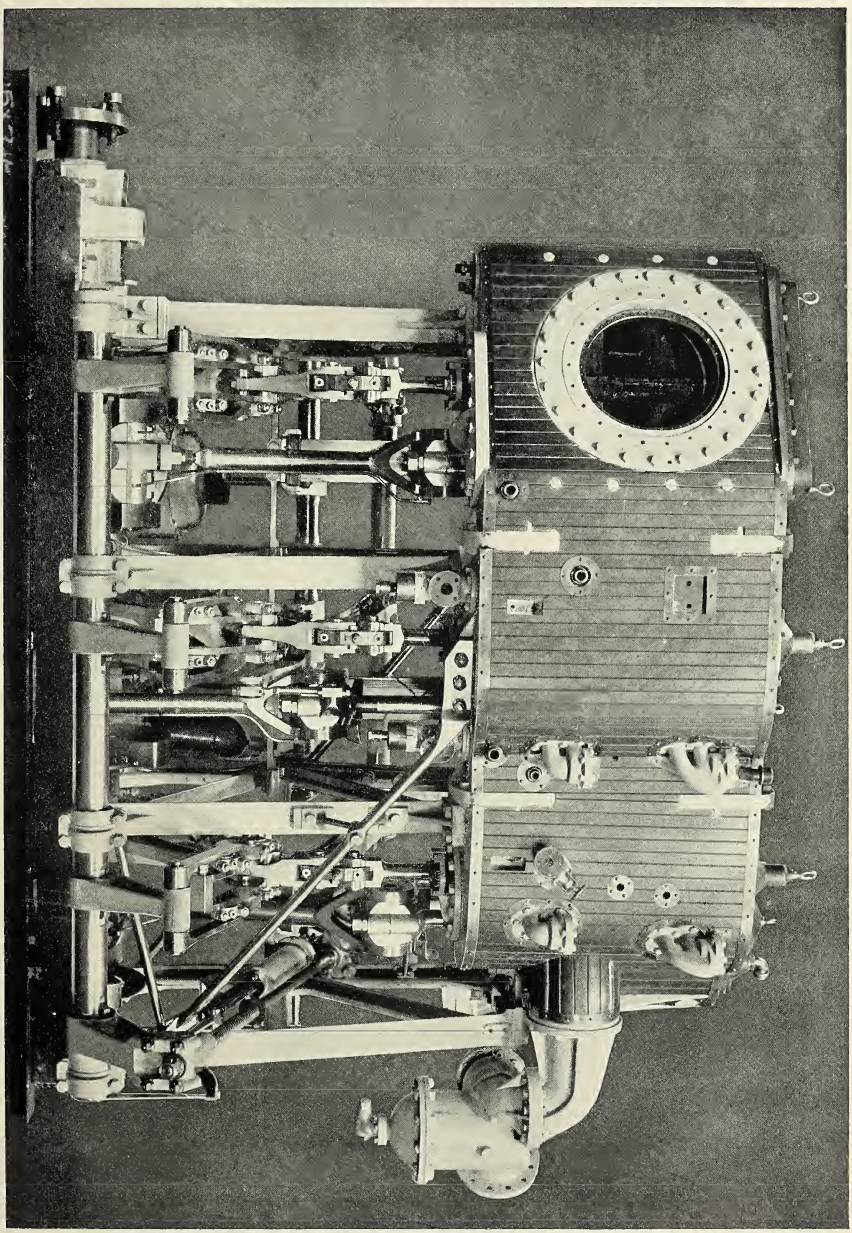
Each vessel is fitted with two brass feed water heaters 14 in. dia. and 5 ft. 3 in. long, the heating surface being about 160 sq. ft. The air compressor, feed water evaporator, distiller for drinking water, and dynamo are located in the engine room.

The machinery of the *Dahlgren* class consists of two distinct independent units. Each engine has its own boiler and condenser. There are, therefore, two Normand water tube boilers of the "Express" type. The grate surface of each boiler is 59 sq. ft., and the heating surface is 2,776 sq. ft. This gives a total grate surface of 118 sq. ft. and a total heating surface of 5,552 sq. ft., the ratio of H. S. to G. S. being, therefore, 46 3-4 to 1. As the designed I. H. P. is 4,200, the I. H. P. per sq. ft. of grate surface designed is 35.6, an unusually high figure, and the heating surface in sq. ft. per I. H. P. is 1.32, an equally low figure. There are 1,550 tubes in each boiler, and these average about 6 ft. long, the outside dia. being 13-16 in. The working steam pressure is 230 lbs. These boilers have an unusually long grate—9 ft. 6 in. The boilers were made as large as possible—indeed, up to the limit in size—so as to obtain the necessary power with but two units, and thus save space and weight with a corresponding increase in efficiency. A large blower, driven direct by a single cylinder engine, is located in the fire room. This fan takes air from the large deck cowl overhead and also from the engine room. Forced draft is fitted in the closed stokehold system, and at full power an air pressure of about 4 in. is expected, the fan making about 750 revolutions per minute. Two auxiliary feed pumps are also located in the fire room.

The electric plant is very complete for vessels of this type, but no searchlights are fitted. The dynamo is a 1 1-2-kilowatt Riker machine, direct coupled to a Sturtevant engine. The drainage system in these vessels include seven steam ejectors, with a capacity of 100 tons each per hour, situated in the different compartments amidships, and two ejectors with a capacity of 20 tons each per hour in the two end compartments.

The designed weight of the completed hull of the *Dahlgren* class was 44.55 tons, and the designed weight of the machinery with water was 78.20 tons. The trial load specified was 20.29 tons, and this weight included 7.06 tons of equipment and 9 tons of coal, the remainder being ordnance weight.

These vessels have been designed to have a radius of action of about 1,500 nautical miles at a speed of 14 knots. They have, as before mentioned, a total bunker capacity of 32 tons, and they will probably burn about 630 lbs. of coal per hour at their cruising speed. The *Dahlgren* and the *T. A. M. Craven* are of about the same size as the U. S. torpedo-boats *Foote*, *Rodgers* and *Winslow*, designed four years ago by the Navy Department. It will be interesting to note, however, that whereas the vessels of the *Foote* class have machinery of about 2,000 I. H. P., the vessels of the *Dahlgren* class are fitted with machinery capable of indicating at least 4,200 I. H. P. on the same displacement—a truly remarkable difference. This great difference in power accounts for the speed raising from 24 1-2 knots in vessels of the *Foote* class to 30 1-2 knots in vessels of the *Dahlgren* class, a difference of six knots. As before stated, the Bath Iron Works have guaranteed a speed of 30 1-2 knots on these vessels, this speed being the highest ever guaranteed on any vessel of the size carrying the usual torpedo-boat trial load. It will be interesting to note also that British 30-knot boats have a displacement of 275 to 325 tons, and all the American 30-knot boats, with the exception of the *Dahlgren* and her sister, have displacements varying from 250 to 450 tons. The *Dahlgren* and *T. A. M. Craven* will be given their official speed tests during the present summer, and the builders are confident that these vessels will soon be recognized as the fastest vessels of their size and type afloat.



THREE CYLINDER TRIPLE EXPANSION ENGINES OF U. S. TWIN SCREW TORPEDO BOAT DAHLGREN—EACH 2,100 I. H. P.

RECENT EUROPEAN ICE BREAKING STEAMERS AND THEIR PERFORMANCES.*

BY H. E. SWAN.

There can be no doubt that the employment of ice-breakers is destined to become a very important factor in connection with steam navigation generally, and that many ports which formerly were partially, and others entirely, closed during the whole of the winter, will become available for commerce all the year round. The first record that we have of an ice-breaker is the *Pilot*, belonging to the port of Cronstadt. She was a small single-screw tug, with very sharp lines and great rise of floor. Her owner, the Russian merchant Britneff, conceived the idea that such a vessel could be utilized for ice-breaking, and therefore had her bow altered so that she could be forced up on to the ice, which was then broken by her weight, and although owing to the smallness of the vessel she could only deal with ice of comparatively small thickness, she embodied the germ of the idea which was destined to have important developments.

The Hamburg authorities, having heard of the *Pilot's* success, decided to have ice-breakers specially constructed for service on the Elbe, the first being *Eisbrecher I.*, built in 1871, and of 600 indicated horse power. From time to time the size and power of these vessels was increased, and their success was such that ice-breakers have now come to be looked upon as a regular part of the harbor equipment, and are able to keep the navigation open throughout the winter. In the meantime, various Scandinavian countries with ice-bound harbors had turned their attention to the subject, and a number of vessels, both to be used as ice-breakers pure and simple and also as ice-breaking ferry steamers, were built, some being propelled by paddles and others by screw propellers both of the single and twin description.

Particulars of these vessels are given in the paper[1] which Captain Tuxen, of the Royal Danish Navy, read at the International Congress of Naval Architects, held in London in July, 1897, and the illustration which he gave of the *Sleipner*, belonging to the port of Copenhagen, of 1,400 tons displacement and 2,600 indicated horse power, is a fair representation of the type of ice-breaker in use up to that time; a main feature being the cutting away of the forefoot from a point on the stem above the water line in a slanting direction, and striking the keel line about one-fourth of the vessel's length from the bow, this form naturally facilitating the mounting of the vessel on to the ice field.

Our enterprising friends, the Americans, had for some time been using ferry steamers so constructed as to be able to make their way through ice of considerable thickness, and they accidentally discovered that a single-screw steamer of this type, when leaving an ice-bound wharf, was able to make her way out better by going astern than ahead, as the disturbance of the water by the propeller had a disrupting influence of a much more important character than might have been supposed. The idea thus given was immediately taken advantage of and embodied in the next vessels to be built, which were given the bow propeller, the first to be so fitted being the *St. Marie*,[2] built in 1893, for service on the great lakes. Experience with the latest ice-breakers so constructed has proved that not only is the bow propeller very valuable, but it is almost indispensable where heavy packs of ice have to be dealt with. With the exception of some of the American vesels, which were built of wood, the whole of the others have been built of iron or steel, of which latter material all the more recent vessels have been constructed.

It would be impossible in the limits of a paper of this description to give many details as regards the construction of such vessels. It will, however, be interesting to the members if I give a few particulars of two vessels built last year, embodying all the latest practice, and which have been at work during the past winter with eminent success. These vessels were the *Sampo*, of 2,000 tons displacement and 3,000 indicated horse power, built for the Finnish Government, and the *Ermack*,[3] of 8,000 tons displacement and 10,000 indicated horse power, built for the Imperial Russian Government. The *Sampo* has one single propeller aft and another one forward, and her chief dimensions are: Length, 202 ft.; beam, 43 ft.; depth to upper deck, 29 ft. 5 in. Her bow and stern have considerable overhang, the contour being such as to strike the ice at a very acute angle, so that when the vessel is driven with considerable force she has a tendency to rise on the ice in a slanting position, which, while it conduces to bringing her maximum weight to bear, does so in a manner which mitigates the blow to the vessel herself.

The *Ermack* marks an immense stride in the construction of ice-breakers, being fully three times as powerful as any vessel previously constructed; moreover, she has four propellers, three placed aft and one forward. Her principal dimensions are: Length over all, 365 ft.; beam, 71 ft.; depth to upper deck, 42 ft. 6 in.; the contour of her bow and stern also shows a quite exceptional amount of overhang, and both she and the *Sampo* had their sides inclined outwards at a considerable angle from the vertical, to lessen the strain when the vessels are being nipped in the ice floes. The whole construction of the *Ermack* is exceedingly strong, and she is subdivided into forty-eight compartments, the water-tightness of which has been tested in the most efficient manner; and as an example it may be mentioned that after the vessel was launched, and her engines and boilers fitted on board and all complete, one of the boiler-rooms was filled with water to the upper deck, the bulkheads practically showing no deflection. This is probably the most severe test to which the bulkheads of any ship have ever been previously subjected, and as the other parts of the hull are relatively as strong, this gives a good indication of the vessel's solidity. The frames are placed 12 in. apart, and the thickness of the ice belt varies from 1 1-4 in. at the ends, where most of the ice-

* A paper read before the Institution of Naval Architects, England.

[1] This paper was published, with engravings, in our issue of September, 1897.

[2] This statement is inaccurate. The first steamer of this type was the *St. Ignace*, 1,200 gross tons, built by the Detroit Dry Dock Co. in 1888, for service in the Straits of Mackinaw. She is fitted with a propeller at the bow of smaller dimensions than that at the stern. For a more complete description of this vessel see the issue of April, 1898.—Ed. M. E.

[3] For engraving of this vessel see issue of February, 1899.

breaking is to be done, and is slightly reduced in other parts less exposed to shocks when breaking ice.

In ice-breakers generally it is highly important to have a model of a rounded form, and to have the outside surfaces as smooth as possible, both seams and butts for this reason being flush plated. It is desirable also that the vessels relatively should be short and broad, as this is found to greatly assist their manœuvring in ice, and prevents the broken pieces from clinging to the shell plating. It is also important to have the pumps of enormous power, connected with trimming tanks both at the bow and stern, and also at the sides of the ship, so that if the vessel gets caught in the ice her horizontal plane may be varied in any sense desired, whereby she can the more readily release herself.

Experience with the *Sampo* and *Ermack* has shown that pack ice of practically any thickness can be negotiated; and in the case of the latter vessel, she on one occasion encountered a pack which was measured and found to be of a total thickness of 34 ft., 9 ft. being above the level of the field, and through which she successfully forced her way—a feat which would have been quite impossible but for the action of the forward propeller. As regards the propellers themselves, I may mention that we have made them both of bronze and of nickel steel, and have not so far had a broken blade, and this in spite of the fact that on many occasions the engines have brought up "all standing," which, I need hardly say, requires their being designed in all their working parts, both as regards scantlings and surfaces, on a basis greatly in excess of what is usual in machinery for ordinary purposes. In operation the *Ermack* has broken composed ice of 8 ft. 3 in. in thickness, and she has gone through field ice of about 40 in., with 6 in. of snow upon it, at a speed of 2 1-2 to 3 knots; moreover, she has been driven at a speed of about 10 knots through clear ice of 24 in., whilst ice under 18 in. has little effect upon her. It is found that snow has a wonderfully great retarding influence upon an ice-breaker, much more so than a similar thickness of solid ice.

Manœuvering powers of the *Ermack* are remarkable, seeing that with her helm only she can turn in a circle of only twice her own length, and her handiness was specially shown when she entered the frozen-up port of Cronstadt on March 16 last, proceeding without stopping through an entrance only 95 ft. wide and berthing herself alongside the quay without assistance, whereas under ordinary circumstances of navigation in open water steamers are in the habit of being assisted by tug-boats.

Her practical utility was not long in being put to the test. Immediately on her arrival urgent word was received from Reval that a number of steamers were in great jeopardy; she at once proceeded there, and was the means of liberating thirty-three steamers of an aggregate value of $7,500,000. She subsequently returned to Cronstadt and St. Petersburg, and was instrumental in relieving and facilitating the entry of some forty more steamers several weeks earlier than if they had waited the ordinary opening of navigation. This performance is a very conclusive proof of the commercial value of such a vessel. When a passage has once been broken, vessels of ordinary construction can usually follow in the channel thus made without suffering injury; where, however, vessels are intended to work regularly in this way, it would be advisable to give them a little additional strengthening, especially as regards the bow, and as regards the propeller, this had better be of steel somewhat stronger than ordinary practice.

It is necessary here to point out that all of the foregoing remarks apply to ice-breaking in the Baltic, or where the ice is formed gradually at moderate temperatures, and that the same result could not be looked for in the case of service in the Arctic regions, where the ice is of a much harder and more brittle description, and it probably would not be prudent to have the bow propeller shipped when a vessel is employed among the heavy ice of the Polar seas.

In connection with the *Ermack* I must not fail to mention the name of Vice-Admiral Makaroff, of the Imperial Russian Navy, but for whose personal initiative this important vessel would never have been built, and from whom we received very much valuable assistance during the vessel's construction.

A very important application of ice-breaking steamers is shown in their ability to form connecting links in railway systems in crossing large stretches of water—which it would be either impossible or too costly to bridge—and of which we ourselves have had two notable examples. Near the town of Saratoff, on the river Volga, there is an important railway traffic, which during the winter was practically suspended, and could only be carried on in a desultory way when the ice was strong enough to bear sledge traffic; but there were occasions both in the spring and autumn when communication, either by sledge or navigation, was absolutely impossible. In this case there was a further difficulty in the large range in the depth of water; it sometimes was as low as 10 ft.; but with the melting snows in spring the water rose to the extent of 45 ft. It became necessary to design a vessel which could not only contend with the ice but load and discharge the freight cars at varying heights. We therefore proposed a twin-screw vessel of the following dimensions: Length, 252 ft.; breadth, 55 ft. 6 in.; depth, 14 ft. 6 in. This vessel has four lines of rails, each pair converging into two hydraulic lifts placed side by side at the bow of the vessel, and it is found in practice that the full load of twenty-four cars can be run off or on to the shore in half an hour, and this at varying heights according to the depth of the water. Owing to the limited draught of the water it was not possible to give this vessel the necessary form to break the heaviest ice, the thickness sometimes being as much as 3 ft.; she, therefore, under these circumstances, works in conjunction with a twin-screw ice-breaker of the ordinary type of 870 tons displacement and 1,500 indicated horse power; but when the ice is of moderate thickness, say about 20 in., the ferry-boat is able to work without assistance. These vessels have now been at work for three seasons, and have maintained the railway service without a single day's interruption.

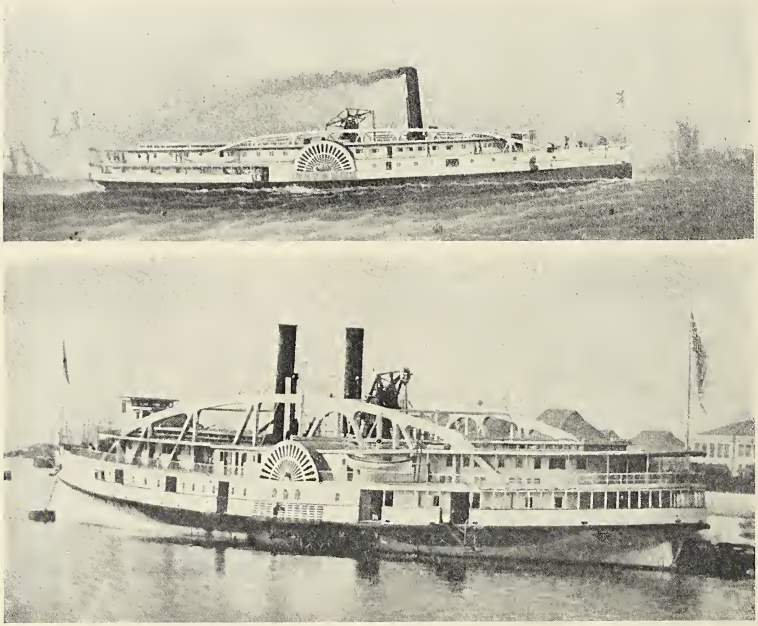
The other important ferry ice-breaker is that which is now being erected on the shores of Lake Baikal, and which, when completed, will form an important connecting link in the great Siberian railroad, the lake at the point in question being forty miles wide. This vessel has a displacement of 4,200 tons, is 290 ft. long, 57 ft. beam, and 28 ft. 6 in. deep to the rail deck. She is fitted with three sets of engines of an aggregate power of 4,000 horses, two sets being placed aft, driving twin-screw propellers, the third set being at the bow. This vessel

has three lines of rail laid on her deck, but as the height of water in the lake does not materially vary, connection with the shore can be made by a movable gangway. As the weather in the lake at times is very stormy, it is found desirable that the carriages should be under cover; therefore the vessel is built with a closed superstructure which gives her very much the appearance of the American lake steamers. In the superstructure is also provided very extensive accommodations for the passengers, who will find it more convenient than being cooped up in the railway carriages during transit. The construction of this vessel marks a record in shipbuilding; the vessel, after being erected in our yard on the Tyne, was taken to pieces, shipped to St. Petersburg, and thence taken a distance of about 5,000 miles overland to the shores of Lake Baikal, which would have been difficult enough had there been railway transit the whole distance, whereas a considerable portion of the road had to be covered by sledge, and this, considering the great weight of parts of the machinery, and including as it did her fifteen main boilers, was a task of some difficulty. The vessel is to be launched this summer and to be ready for next season.

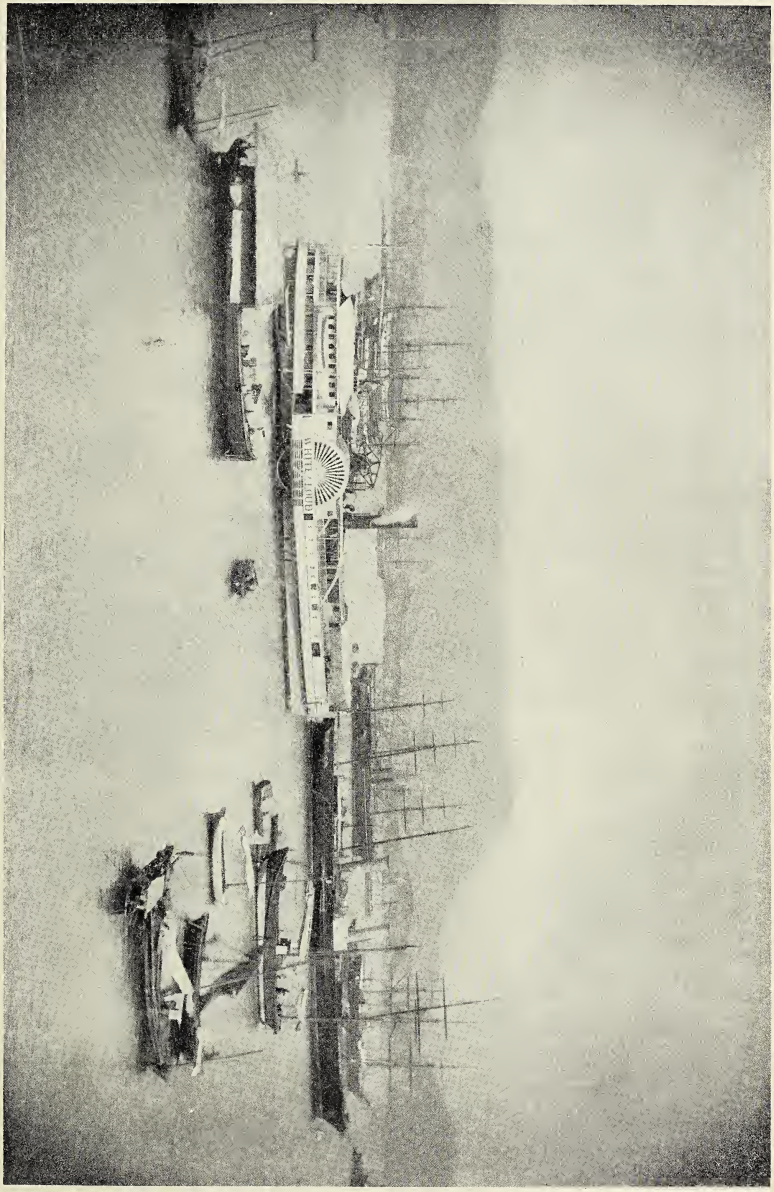
In conclusion, I can only reiterate my belief that the employment of ice-breaking vessels has not yet reached anything like the importance that it will yet achieve, and that still more important developments in this class of vessel may be expected in the future.

AMERICAN SIDEWHEELERS SENT TO CHINA UNDER THEIR OWN STEAM.

From time to time recently there has been much comment in the technical papers of various countries on the successful ocean voyages of war vessels of different classes. Much credit, for example, was recently claimed for the German built torpedo boat destroyers that steamed from the North Sea to China successfully. About the same time much credit was claimed, also, for the work of the British builder, whose torpedo boat destroyers made the voyage to Japan under their own steam. These and similar performances, indeed, have been generally considered as extraordinary. In view of the fact that this style of craft is built for sea service, and ought to be able to make long trips at reduced speed, it is rather difficult to understand why surprise should be expressed when such boats actually do what they were intended to do, or perform services similar to that which they may be called upon to perform in time of war. The trip of the battleship *Oregon* from the Pacific to the Atlantic coast at the beginning of the Spanish war produced, what is familiarly called, a "profound impression" in naval circles generally, though among members of the merchant marine the real grounds for such wonderment was not so clearly seen, when comparisons were made with the regular work of merchant steamers—taking into con-



AMERICAN SIDEWHEELERS KIN KIANG AND PLYMOUTH ROCK, THAT STEAMED FROM NEW YORK TO CHINA.
Original photographs by Pun Lun, Queen's Road, Hong Kong, China.



AMERICAN SIDEWHEEL STEAMER WHITE CLOUD, IN THE PORT OF HONG KONG, CHINA, JUNE, 1859, AFTER MAKING THE TRIP FROM NEW YORK UNDER HER OWN STEAM.

Photograph by kind permission of Captain Samuel Newton, retired.

sideration, of course, the size and power of the war vessel.

If the performances of these various vessels and their crews are so meritorious, what credit must be due the men who built and manned the boats that steamed unaided from the port of New York to the Pacific coast and Asiatic ports many years ago?

The *City of Kingston*, a small Hudson River propeller with light wooden upper works, was bought by a Pacific coast concern several years ago. She left New York under her own steam, went south and through the Straits of Magellan and up along the Pacific coast to Puget Sound, making stops for coal on the way—in fact, making a slightly longer trip than the famous trip of the *Oregon*, only in the opposite direction. Taking into consideration the size and light build of the boat, her performance was actually deserving of great credit.

The Hudson River sidewheel beam engine steamboat, with its wooden hull, overhanging guards and light wooden superstructure would hardly be classed, nowadays, as a seagoing type. Between forty and fifty years ago, however, a number of such boats were built in New York for river service in the Chinese Empire, and they invariably made the run out under their own steam without serious mishap. This style of boat has undergone little change in later years, and is still fitted with leg boilers, working at 45 to 50 lbs. pressure, and simple engines with single cylinders. The only improvement over the old styles is in the size and construction of the paddle wheels. Of the boats that went to China several had wheels with iron arms. At the time these boats went out the Suez Canal was not in existence, and so the usual course was around the Cape of Good Hope.

One of the first American boats for Chinese waters was the *Confucius*, ordered in New York by Russell & Co., of Hong Kong, in 1849. The hull was constructed by Thomas Colyer, and the engine by H. R. Dunham. The steam cylinder was 50 in. dia. and 120 in. stroke. This boat arrived out safely, and though built for freight and passenger service, was afterwards purchased by the Chinese Government and converted into a gunboat. After the sale of the *Confucius* the owners ordered another boat here to take her place. This was the *River Bird*, which went out in 1856. After a short career as a merchant vessel the *River Bird* was chartered by the British Government, during the Indian mutiny, to convey troops for the relief of Lucknow, and she was wrecked in the Hooghly River in 1857. Subsequently Russell & Co. placed an order here for a third vessel to replace the *River Bird*, and this boat when built was named the *White Cloud*. This vessel, also built by Thomas Colyer, was 175 ft. long, and was fitted with a beam engine with cylinder 44 in. dia. and 120 in. stroke, built by the Morgan Iron Works. In the accompanying large engraving the *White Cloud* will be seen lying at the port of Hong Kong on her arrival out in June, 1859. This is a reproduction of a photograph taken at the time, and which from age has become rather indistinct. The run of the *White Cloud* to China was made on a reduced coal consumption, as coaling stations were few and far between, and as a precaution two small masts were fitted so that sail power could be used in case of necessity. At each coaling station a stop of several days was made to enable the crew to make a few slight repairs.

A short abstract of the log of the *White Cloud* on this remarkable voyage will be of interest:

Left New York March 2, 1859. Captain, Josiah Paul; Chief Engineer, Samuel Newton.

Arrived at St. Vincent, Cape Verde Islands, West Coast of Africa, in 17 days. Distance run, 2,919 miles. Coaled.

Left for Cape of Good Hope and arrived in 23 days 12 hours. Distance, 3,896 miles. Coaled.

Left for Point de Galle, Island of Ceylon, and arrived in 24 days. Distance, 4,380 miles. Coaled.

Sailed for Hong Kong, stopping at Singapore, and dropped anchor in Hong Kong harbor June 7, 1859. Distance 3,000 miles.

Total distance from New York, 14,195 miles.

The crew of the *White Cloud* celebrated the Fourth of July, 1859, by running the trial trip on the Canton River. This was entirely satisfactory and the boat was put in service between Hong Kong and Canton, and subsequently between Hong Kong and Macao. After twelve years of good service she was lost in a typhoon in Macao harbor. As may be noticed in the engraving, the *White Cloud* was fitted with a small gun, as pirates frequented the Chinese waters.

Another steamboat, the *Plymouth Rock*, built in 1863, left New York in September, 1864, and steamed to China, where she plied on the Canton River. Later she was put on a route on the Yang Zee River, trading between Shanghai and Hankow. Her name when launched was *Foong Suey*, but this was changed to *Plymouth Rock* on arrival out at China. Later several other boats were built for service in Chinese waters. One of these was the *Nantilus*, built by Fletcher, Harrison & Co., in 1866. Her engine was a duplicate of that originally fitted in the famous Hudson River passenger steamer *Mary Powell*. The steam cylinder was 62 in. dia. and 120 in. stroke.

S. S. Kinfauns Castle.—As an instance of the increasing dimensions of liners on long ocean routes, the *Kinfauns Castle*, building on the Clyde for the Cape Mail Service, is an interesting vessel. Her dimensions are: Length, over all, 532 ft. 3 in.; beam, extreme, 59 ft. 3 in.; depth, moulded, 38 ft. 9 in.; gross tonnage, 9,700 tons, and horse power, about 10,000 indicated. The vessel will have accommodation for nearly 700 passengers of all classes. She will be fitted with twin screws, driven by quadruple expansion engines, with a working steam pressure of 210 lbs. The interior arrangements have been very carefully planned for the comfort of the passengers. There will be a very extensive equipment of electric fans, and the refrigerating apparatus will also be very extensive, cool drinking water being supplied at many points in the living quarters. The evaporating plant will have a capacity of 13,000 gallons of drinking water a day, and all the water will be carefully filtered in the most scientific method. Loud speaking telephones are fitted between the working stations above deck and the engine room and the tiller room aft.

Mishaps to war vessels under steam do not appear to be confined to the American Navy. A recent report from England gives particulars of a collision between the battleship *Sans Pareil*, 10,500 tons, and the full rigged ship *East Lothian*, off the Lizard. The ship sank and one man was drowned.

CONSIDERATION OF THE INDICATOR AND ITS USES ON BOARD SHIP—VII.*

BY R. W. JACK.

(Concluding Chapter.)

The lead line is a continuation of the compression curve, and is usually obtained by an additional angular advance of the eccentric sheave. The point of opening to steam is, therefore, fixed in the first instance by this consideration, and it may be altered only by changing the position of eccentric sheave, the travel of the valve, or the outside lap. The effect on the lead produced by linking depends upon whether the eccentric rods are open or crossed when the crank is on the bottom center. The rods are said to be crossed when they occupy the position shown in Fig. 17, and to be open as in Fig. 18.

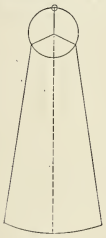


FIG. 18.

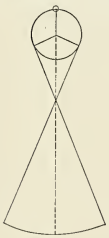


FIG. 17.

With open rods the effect of linking up is to increase the lead, while with crossed rods the reverse is the case, the lead is reduced.

Generally speaking, in the matter of indicator diagrams we may be permitted to say that the more nearly we can obtain an approach to the ideal conditions the more usefully will the steam be employed. To bring those conditions to mind we might just recapitulate them in order, viz.: First. Waste steam space or total clearance at the ends of cylinder should be as small as possible. This space evidently depends upon the area of the steam passages, the distance between the valve face and cylinder, and the actual clearance allowed to the piston. For any given diameters of cylinders the ratio will be nearly the same, but as the effect of clearance upon the expansion curve depends upon the proportion the clearance bears to the volume of cylinder, or rather to that portion of it filled with live steam, it will be seen that the longer the stroke of the engine and the further steam is carried, the less cause there will be to consider this defect. Second. The pressure of steam in cylinder should coincide with that in the steam chest till the point of cut-off. The steam line of a diagram is in fact the result of a compromise between a more correct line obtained by a certain area of valve with sufficient travel, and the practical drawbacks of excessive friction in the case of a common flat side valve. Third. The expansion curve should not be interfered with by a leaky piston or valve. All that can be done to improve the curve is in the direction of improving the mechanical condition of the engines in the matter of ensuring absolute steam-tightness of piston and valve, whilst regard should also be paid to the efficiency of the non-conducting arrangement of the body of the cylinder. Fourth. The exhaust should not take place till near the end of the stroke, and should instantly fall to the mean back pressure. The exhaust may be made to take place early or late, as we have seen, but its position in practice depends upon the amount of compression to be allowed. Fifth. The back pressure should be fairly uniform. Perfect uniformity of back pressure is possible only when the ratio of influx and efflux of the steam are equal, but a slight variation is of little consequence. Sixth. The compression should not be excessive. The compression in a cylinder, so far as it is possible for us to deal with it, without at the same time creating an objectionable feature at the moment of opening to exhaust, should be so adjusted as not to exceed all that is found necessary to the smooth working of the engines, and this should be attained by a moderate rise of the curve. Compression in a cylinder carried beyond this limit is produced at the expense of causing a reduction of area of the diagram representing actual work, and though this is not theoretically a loss, it is to be expected that besides conducing to liquefaction of the steam the tendency to leakage is also aggravated. A certain amount of compression, however, compensates the evil of necessarily filling the passage and clearance in the cylinder with live steam.

The behavior of the steam during the entire interval of its passage through the cylinders may be exhibited by combining the cards taken from each engine in series. This is effected by drawing each diagram to the same scale, both as regards pressures and volumes. The following instructions should now make themselves clear: Take the three sets of cards shown in Fig. 19

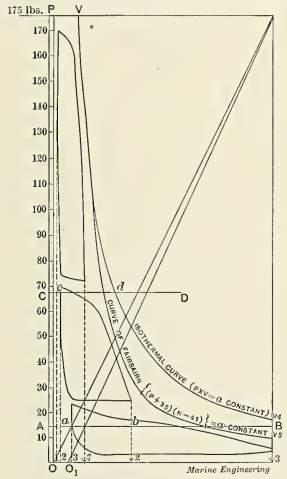
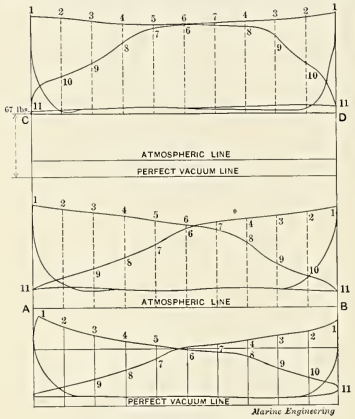


FIG. 19.

(Page 112) from a triple compound engine. Divide each of the cards in the usual way into 10 equi-distant divisions, and choose any convenient scale to measure volumes and pressures. For simplicity, we will use the scale of pressures to which the L P diagram is drawn. It should also be distinctly un-

*From a paper read before the Institution of Engineers and Shipbuilders at Hong Kong.

derstood that we deal only in absolute pressures, *i. e.*, gauge pressure, plus 15. Draw two lines $O\ P$ and $O\ V_3$ at right angles to represent the lines of pressure and volume respectively. The point O will be the starting point or zero of both. We will suppose for the purpose of illustration, though it should be approximately ascertained, the mean clearance or idle space of each end of the cylinders to be $\frac{1}{10}$ of the space swept by the piston, and which will, therefore, be also represented by $\frac{1}{10}$ of the length of each indicator card. From the point O, lay off $Ov_3 = \frac{1}{10}\ v_3\ V_3$—, and proceed to draw in the L P indicator card as taken from the cylinder taking the mean pressure of both ends, *i. e.*, the mean of the pressures 1 and 1, 2 and 2, etc. The scale to which the pressures of the L P card are drawn is $\frac{1}{16}$ in. to 1 lb. It will be more convenient in marking off the pressures on the M P card to measure from a horizontal line drawn just below the back pressure line at a fixed distance from the base $O\ V_3$; thus we will, therefore, take the pressures on this card from the atmospheric line $A\ B$. The scale to which the indicator diagram of the M P engine is drawn is $\frac{1}{32}$ in. to 1 lb. To enlarge this diagram to the same scale as the L P we must, therefore, multiply each pressure by $\frac{2}{16}$ or 2. Again, the distance Ov_2 is equal to $\frac{1}{10}$ of the distance $v_2\ V_2$, where $v_2\ V_2$ equals the length of the M P, supposing it to have an area equal to that of the L P cylinder. In other words,



SEPARATE DIAGRAMS OF FIG. 19.

$$v_2\ V_2 = \frac{Volume\ of\ M\ P\ cylinder}{Area\ of\ L\ P\ cylinder} \text{ or}$$

$$\frac{Diameter\ of\ M\ P\ cylinders^2 \times Length\ of\ stroke}{Diameter\ of\ L\ P\ cylinder^2}$$

where the length of stroke is equal to the length of L P, *i. c.*, the distance $v_3 V_3$. Divide the distance $v_3 V_2$ or $a\ b$ into 10 equal parts exactly as in the full-sized card and mark off the pressures from the line $A\ B$, in every case using the mean of those pressures which are at equal distance from each end of the indicator card. The figure drawn through those points will represent the M P indicator card to the same scale as that to which the L P is drawn, and it, therefore, should be merely a continuation of the L P curve following the laws of expansion or compression. The same construction holds for any number of cylinders in series. Ov_1 is the mean clearance of the H P cylinder, and is equal to $\frac{1}{10}$ of $v_1\ V_1$. The length $v_1\ V_1$ represents the volume of the H P cylinder compared with the L P, and, as before,

$$\text{is equal to } \frac{Diameter\ of\ H\ P\ cylinder^2 \times stroke}{Diameter\ of\ L\ P\ cylinders^2}.$$ Again

draw the line $C\ D$ parallel to the base, and at a distance from it which will suit our convenience in laying off the pressures on the 10 equi-distant ordinates. In this case we have drawn it 67 lbs. from the base $O\ V_3$. The scale to which the H P cylinder diagram has been traced is $\frac{1}{64}$ in. per lb., so that to make the pressure correspond to a scale of $\frac{1}{16}$ per 1 lb. we must multiply each mean pressure taken from the card by $\frac{64}{16}$ or 4, and lay them off on the new ordinates raised from the base line $C\ D$. Trace the figure through those points on the ordinates which shall show H P cylinder diagram to the same scale as the L P and M P engine diagrams.

It will be interesting now to draw the ideal or hyperbolic curve, when it will become clearly apparent where the varied actions of liquefaction and re-evaporation of the steam take place and to what extent. For this purpose it may be best to take the actual point of cut-off in the H P cylinder and suppose that the boiler pressure is fully maintained up to that moment. The indicator card may show the steam to be somewhat wire-drawn, but it must be remembered that a certain amount of liquefaction almost invariably takes place during the same interval, so that we may safely assume for present purposes that the quantity of steam expanding throughout the cylinders is that represented by the volume which is occupied by the steam (not including the clearance) at the point of cut-off in the H P cylinder, and at a density due to the full boiler pressure. Assuming, then, the pressure to be equal to $O\ P$ and the volume to be $P\ V$, the curve $V\ V_4$ is drawn according to the directions already given. The combined card is frequently compared with the curve of saturated steam drawn to Tate's formula of $(P + .36)\ (V - .41) =$ a constant, and in this case the possibilities of improvement are indicated by the spaces which the combined cards fail to fill. It has, too, been shown how this construction, which is merely a hyperbolic curve drawn from a point found by the formula, is effected, and the efficiency of steam-jacketing is decided by the balance of power gained in comparison with that which is lost by condensation in the jacket.

There are many other interesting experiments which may be effected by the aid of the indicator, for its utility is not confined merely to its application to the steam cylinders of an engine, but may be extended to any chamber or receptacle for the measurement of pressure, either constant or variable. It is sometimes required to ascertain the distribution of steam in a cylinder in relation to the position of the slide valve, and for this purpose the motion must be taken direct from the motion of the valve itself. The eccentric revolving, as it does, in the same direction as the crank, the various positions may be judged accordingly. In an ordinary diagram the points where the valve closes to exhaust, and where it opens to steam, are often very indefinite, owing to the slowness of the motion of the piston, while if the motion of the indicator barrel be taken from an engine attached to the same shaft, but whose crank is

set at an angle to that of the engine with which the cylinder of the indicator is in communication, the relative movements at those points (compression and lead)

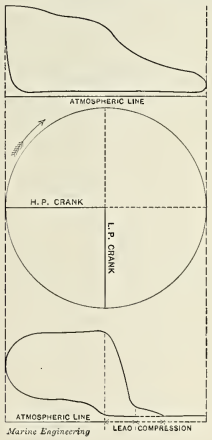


FIG. 20.

are accelerated as a result of the relative positions of the two cranks. The purposes for which this arrangement is primarily useful are a more exact determination of

FIG. 21.

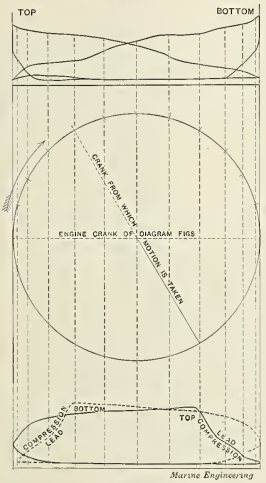


FIG. 22.

the extent and value of the lead opening and the curve of compression. Suppose, for instance, that the indicator is attached to the H P cylinder of a compound engine, and the motion of the paper drum taken from the L P crosshead. Then the diagram taken under those conditions would be something like that shown in Fig. 20. The direction of revolution is coincident, but the L P crank following at an angle of 90° alters the various points on the diagram. The curves also become deformed, and their extent in the length of the diagram is diminished or increased according to the relative velocities of the two pistons, but our object of clearly showing the periods of compression and admission of steam is attained, and the accuracy of the setting of the valve more easily defined, as far as those two critical points are concerned. The two diagrams shown in Figs. 21-22 are actual examples of diagrams taken under the two different conditions. Fig. 21 is the diagram taken in the usual way, and Fig. 22 is a diagram taken from the same cylinder, but the motion of the paper is taken from an engine whose crank is set at an angle of 120 deg. behind the crank of the engine which we are considering. With a little thought the figure explains itself.

The indicator may usefully be applied to pumps of all descriptions either for the purpose of calculating the

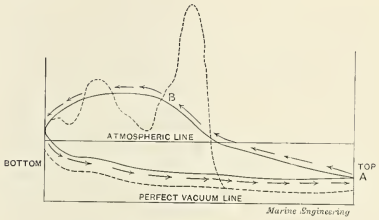


FIG. 23.

power required to work them or to detect any abnormal conditions which may interfere with their efficient and smooth working. But I suspect that I have already encroached upon the limits which might well be set to papers of this description, and I beg simply to append a few diagrams from pumps, with short explanatory notes. The diagram marked Fig. 23 is one taken from the bottom end of a vertical, double-acting circulating pump. The diagram which is shown in full lines is taken under normal conditions of work with engines running at 120 revolutions per minute. The arrow-heads show the direction of motion, and the ends of the stroke are marked top and bottom. This card is taken with a L P spring, and it will be noticed that it is almost exactly a counterpart to that which we might expect from a L P cylinder, the only difference being that it is reversed; that is, compression takes the place of expansion. Beginning at *A* when the plunger is on the top, the air which has been drawn in through the pet valve is compressed until the pressure rises sufficiently to overcome the resistance due to the head of water above the discharge valve on the ship's side, and the friction of the water through condenser tubes, etc. At the point *B* the pressure has attained its maximum when the resistance offered by the flow of water is exactly balanced by the pressure in the pump chamber. Towards the end of the stroke the pres-

sure falls partly on account of leakage and probably in part due to the retarded motion. When the plunger reaches the bottom end of its stroke the pressure falls somewhat gradually, owing to a small amount of confined air, but during the return stroke the pressure in the chamber diminishes until the plunger arrives at the point whence we started. The figure shown in dotted lines is a diagram taken from the same pump representing the effect of closing the pet valve. It will be observed that in this case there is little or no compression curve, and that the plunger strikes the inert body of water almost solidly with considerable force, so that the inertia of the water causes a momentary resistance far in excess of the normal working conditions. On the return stroke it may also be noticed that the vacuum

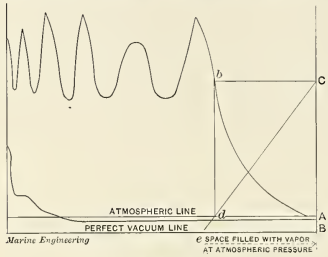


FIG. 24.

formed on the same side is more complete, but the danger of entirely excluding air from the pump chamber will be readily recognized and valued by practical engineers.

Diagram, Fig. 24, is taken from the feed pump of the same engine with the pet valve just slightly open, working at the same speed against a boiler pressure of 150 lbs. per sq. in. The compression curve is fairly uniform, and the immediate rise shows that the air admitted occupies very little space. By describing a parallelogram round the two extreme points of the curve *a* and *b* we may roughly locate the origin of the curve, and thereby estimate the space which the air at atmospheric pressure occupies in the length of the pump barrel when the ram

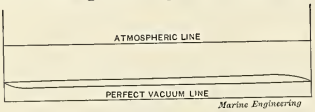


FIG. 25.

begins the down stroke. The efficiency of the pump seems to be well maintained, being nearly two-thirds of the stroke, or 66 per cent. The serrated line of pressure is probably due to the sudden opening of the check valve, the speed of the ram, which is direct acting, traveling at a mean velocity of 480 ft. per minute, and in part to the unsuitability of the indicator itself, which was a Richards. The temperature of the feed water at this point was 152° F., and this fact doubtless accounts for the small amount of vacuum shown on the up-stroke.

Diagram Fig. 25 is that from the bottom of an air pump having three sets of valves. It shows how really little there is for this pump to do after attaining a working vacuum; but having to deal with a highly attenuated vapor, only a pump of large capacity could efficiently dispose of it.

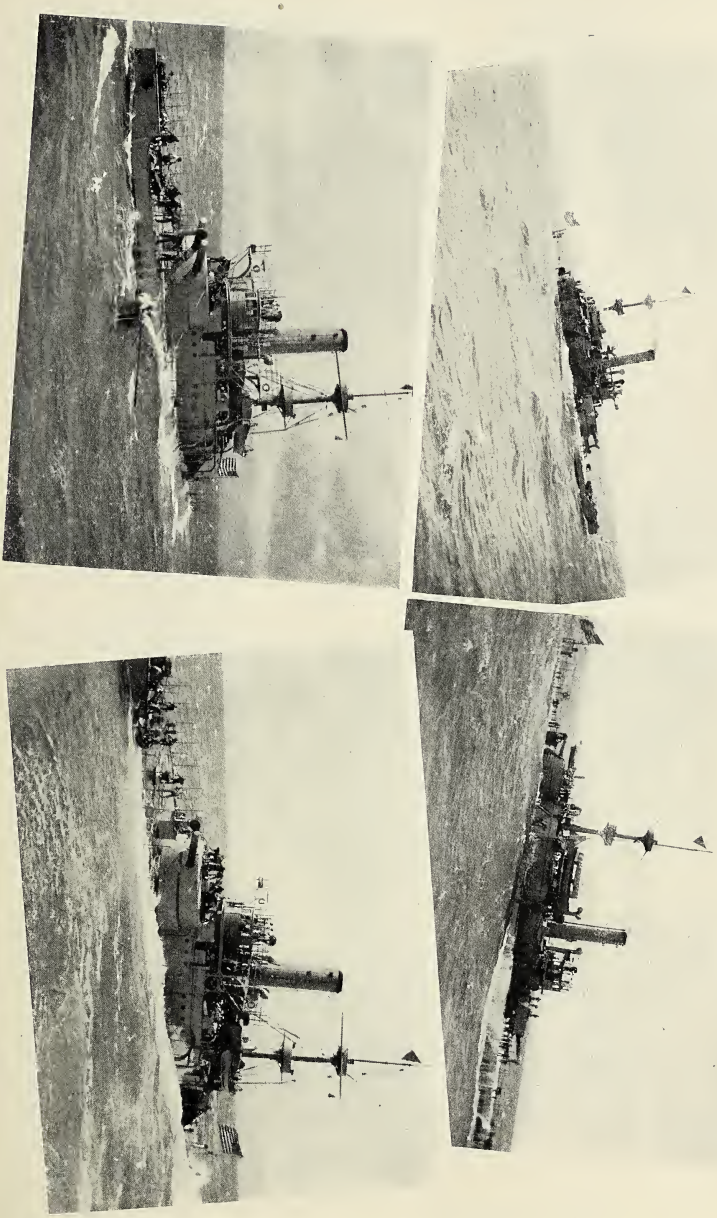
I should state in explanation that the object of the present paper has been to present to the members of this institute a summary of the principles upon which the economic value of steam depends, and to trace the connection between the simple laws of expansion, as illustrated by an ordinary diagram, and the modifications involved in practice, rather than simply to record the conditions which accompany or account for the peculiarities of indicator diagrams. I have adopted this method under the belief that those other papers which are to be read on the same subject will deal more exclusively with indicator diagrams taken from engines which are varied both as regards their design and the work which they are intended to perform.

U. S. Monitor Monadnock at Sea.

Among the heavy war vessels now on duty at Manila is the monitor *Monadnock*, which, in spite of its official designation as a "coast defense" vessel, made the trip across the Pacific without mishap and arrived out ready to do business. A very interesting set of photographs showing the behavior of this vessel at sea are reproduced on page 115. These were taken by J. T. McMillan, of the U. S. Hydrographic Office at San Francisco, who served as a volunteer naval officer in the Far East. The views were taken when the vessel was near Honolulu, in comparatively smooth water. There is no class of vessel in our Navy the usefulness of which has been the cause of more discussion than the monitor. The splendid record made by this type of ship during the Civil War made many friends for the type. During the Spanish War, however, there was much criticism of the type, it being charged that the monitors made very unstable gun platforms, and were deficient in steaming capacity at sea. The consensus of opinion among those who have to operate such vessels seems to be that they are best suited for harbor work, or as coast defense ships. Several long ocean voyages stand to the credit of the monitor type, so that whatever their effectiveness in a naval engagement at sea might be, there can be no doubt of their seaworthiness. This, of course, is quite aside from the question of comfort, etc., of those on board. Under the conditions in which the present photographs were taken the only dry spots on the vessel were the tops of the turrets and superstructure.

The *Monadnock* is an iron double-turreted vessel, in dimensions: Length, 259 ft. 6 in.; beam, 55 ft. 6 in.; draught, 14 ft. 6 in., and displacement 3,990 tons. She is fitted with twin screws and horizontal triple-expansion engines of 3,000 I. H. P., and is supposed to have a sea speed of 12 knots. The coal capacity is very limited, her bunkers holding only 250 tons. Her armament consists of four 10 in. breech loaders, two 4 in. rapid fire guns, and a variety of small rapid fire guns in her secondary battery. She is protected with varying thickness of armor, ranging from 11 1-2 in. on the barbettes down to 1 3-4 in. on the protective deck. Her original commission is dated February 20, 1896. The complement is 26 officers and 157 men.

It will be remembered that there are now under construction in private yards four harbor defense monitors, each of a normal displacement of 2,700 tons.



U. S. DOUBLE TURRETED MONITOR MONADNOCK ON HER WAY TO MANILA—PHOTOGRAPHED ON THE PACIFIC NEAR HAWAIIAN ISLANDS.

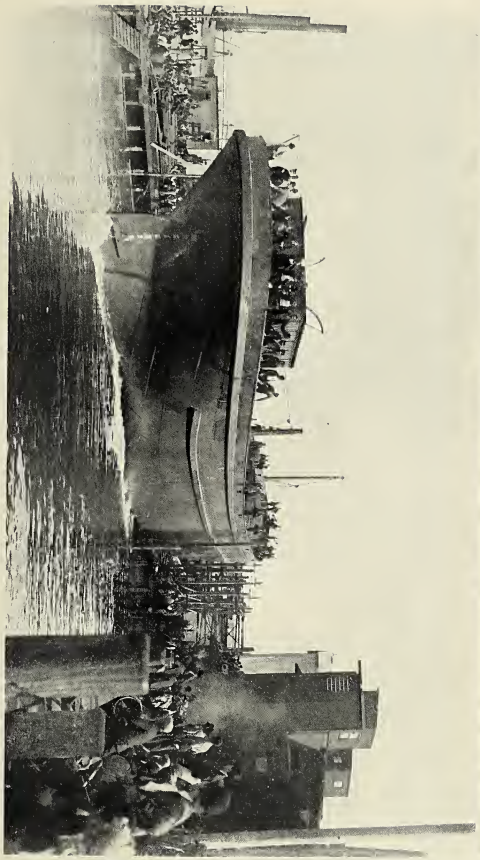
STEEL SEA-GOING TUG GYPSUM KING BUILT IN NEW YORK HARBOR.

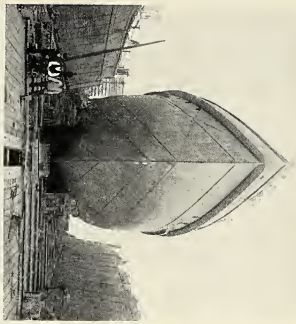
Among the steel shipbuilding plants which have recently come into existence, that of the Burlee Dry Dock Co., Port Richmond, Staten Island, is an interesting example. This concern is an extension of an old established wooden shipbuilding plant on the same site, to which was added a neighboring machine shop and the combined interests then put in a very fine plant for the construction of steel hulls and machinery. The president of the company is William J. Burlee, and the secretary and treasurer W. J. Davidson. Though the new yard has only been in operation less than a year, several highly successful vessels have been turned out. The first vessel completed was the tug *Fred. B. Dalzell*, of New York, and following this came the ocean-going tug *George's Creek*, of Baltimore, for the Consolidated Coal Co. This vessel has exceeded the contract requirements for towing and speed. Later came the *Gypsum King*, one of the largest and most powerful ocean-going tugs ever built in this country. She was built to the order of J. B. King Co., Windsor Plaster Mills, Staten Island, N. Y., for the purpose of towing barges laden with gypsum from the Bay of Fundy to the owner's works. Since she was completed the *Gypsum King* has made four round trips. The trip home with a tow occupies four days, and on each occasion she has brought more than 4,000 tons of gypsum at an average rate of speed of 9 knots, on a coal consumption of about 17 tons in 24 hours—a fine performance and one showing that the conditions of service have been very well met in the new vessel.

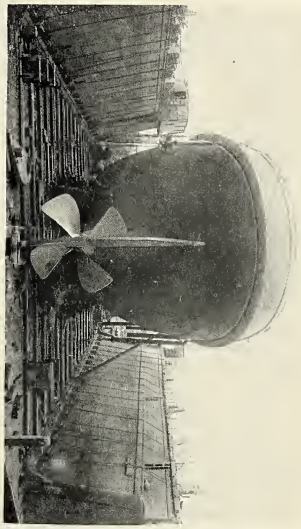
The yard also received orders for three steel barges from the same owners, each to have a capacity of 2,000 tons. One of these barges has been completed and put into commission and the others are well under way in the yard. Through the courtesy of Robert C. Monteagle, chief draughtsman of the builders, we are able here to present several interesting photographs of the new tug *Gypsum King*, and accompanying data.

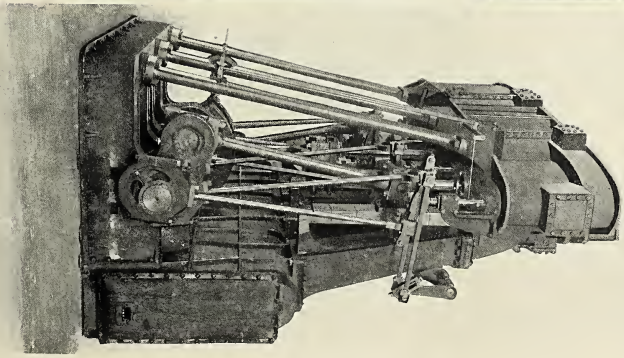
This vessel has the appearance in the water of a trading steamer rather than a tug. The hull is of mild steel, with double bottom extending between the water tanks at the ends, the hull being constructed according to Lloyd's rules. Her dimensions are: Length, stem to stern on deck, 165 ft. 0 in.; beam, moulded, 29 ft. 4 in.; depth from top of deck beam at side to top of keel at lowest place, 19 ft. She has five steel bulkheads, three of which are watertight. At the bottom of each bulkhead there is a composition sluice gate which can be operated from the main deck. This latter is of steel throughout, covered on the open spaces with heavy pine planking. The deck house is 90 ft. long and 16 ft. maximum width, built of steel. At the forward end of the house the steam steering engine is located, and aft of this on the starboard side the mate's room and on the port side a large ice-box. Next comes the mess room, the full width of the house, with doors opening into the galley next aft. A steel bulkhead separates the galley from the coal chute leading into the bunkers below. The next compartment aft is occupied by donkey boiler, crew's water closets, and uptakes from the main boilers. Aft of this the owner's sitting-room occupies the entire width of the house and communicates with two roomy staterooms and a bathroom and toilet. Another steel bulkhead cuts off the machinery space, and aft of this are the engineer's cabins on each side, with doors communicating with

STEEL TUG GYPSUM KING READY FOR SEA.



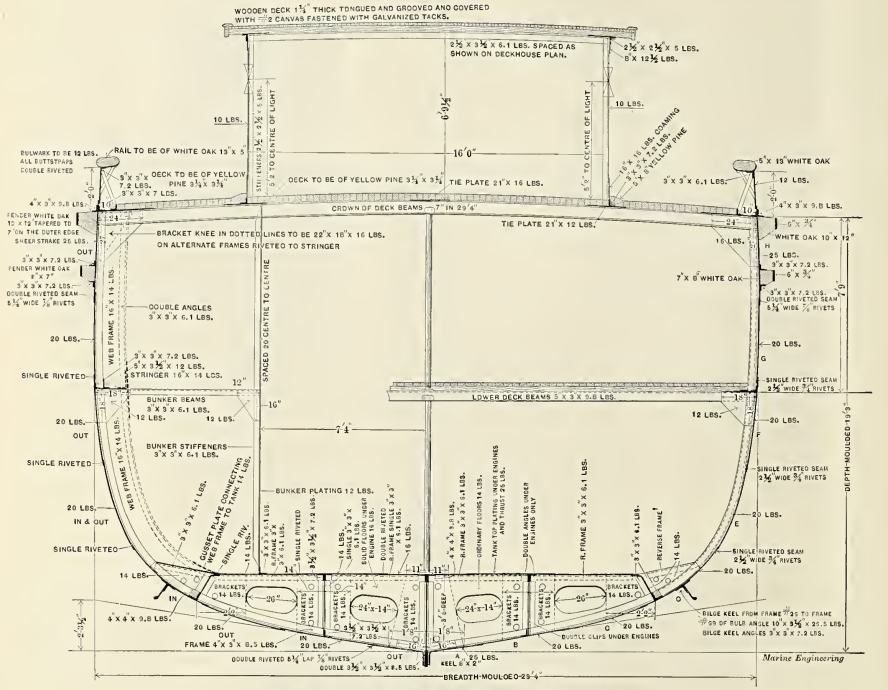






VIEWS OF HULL AND MACHINERY OF STEEL SEA-GOING TUG GYPSUM KING, BUILT FOR THE J. E. KING CO. FOR ATLANTIC COAST SERVICE—563 GROSS TONS.

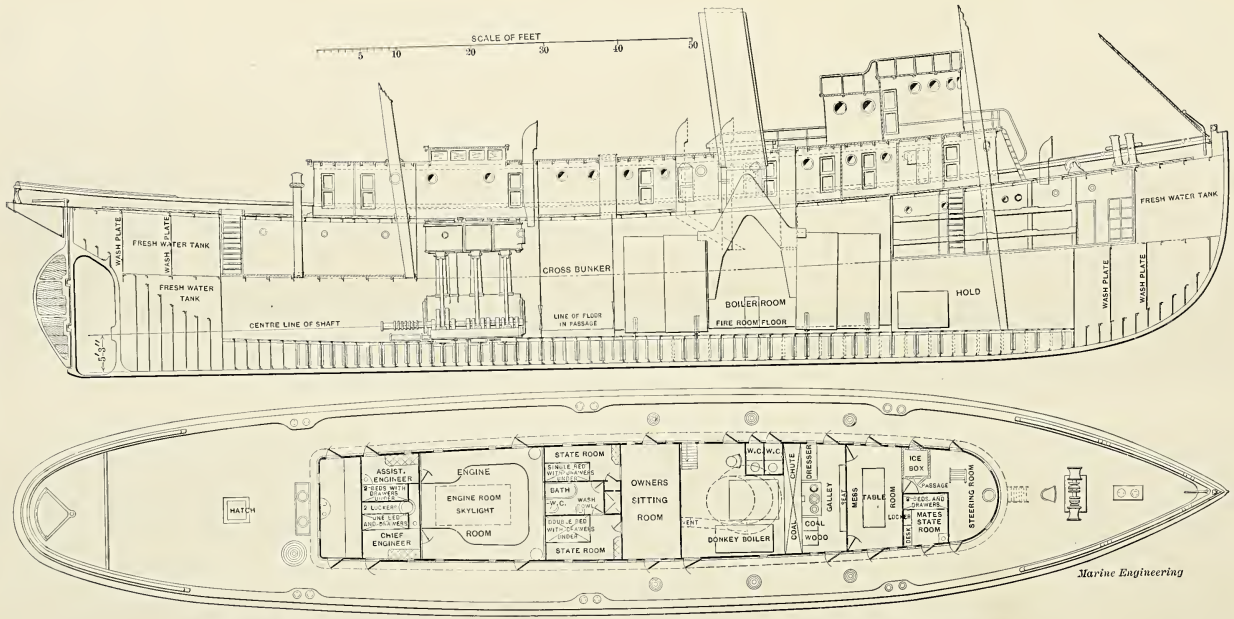
the upper grating in the engine room. The extreme after end of the house can be used for crew accommodation or for stores as need be. At the forward end of the steel deck house and on top is the pilot house and captain's room, also of steel plate, 19 ft. long. A ladder with brass rail leads to the top of the pilot house, which can be used for observation in fine weather. There are three coal bunkers, two at the sides and one cross-bunker between the engine room and boilers, with a total capacity of 300 tons. Coal is loaded through chutes in the house and also through the deck rings. Fresh water tanks are fitted at each end up to the height of the main deck, with a total capacity of 90 tons. Bilge keels are carried along the sides for a distance of about 72 ft. Communication with the lower deck, over the forehold where the crew is berthed, is


WOODEN DECK 1¼" THICK TONGUED AND GROOVED AND COVERED WITH 2 CANVAS FASTENED WITH GALVANIZED TACKS.
RAIL TO BE OF WHITE OAK 13" X 5"
DECK TO BE OF YELLOW PINE 3½ X 3½"
DECK TO BE OF YELLOW PINE 3½ X 3½" TIE PLATE 21" X 16 LBS.
CROWN OF DECK BEAMS 7" IN 29'4"
TIE PLATE 21" X 12 LBS.
BRACKET KNEE IN DOTTED LINES TO BE 22" X 16" X 16 LBS. ON ALTERNATE FRAMES RIVETED TO STRINGER
DOUBLE ANGLES 3" X 3" X 6.1 LBS.
3" X 3" X 7.2 LBS.
5" X 3½" X 12 LBS. STRINGER 16" X 14 LBS.
LOWER DECK BEAMS 5" X 3" X 9.8 LBS.
BUNKER BEAMS 3" X 3" X 6.1 LBS. 12 LBS. 12 LBS.
BUNKER STIFFENERS 3" X 3" X 6.1 LBS.
BUNKER PLATING 12 LBS.
WEB FRAME 16" X 14 LBS.
SINGLE RIVETED
SINGLE RIVETED SEAM 2½" WIDE ¾" RIVETS
DOUBLE RIVETED SEAM 6½" WIDE ⅞" RIVETS
WHITE OAK 10" X 12"
7" X 8" WHITE OAK
5" X 15" WHITE OAK
4" X 3" X 9.8 LBS.
3" X 3" X 6.1 LBS.
FRAME 4" X 3" X 8.5 LBS.
4" X 4" X 9.8 LBS.
DOUBLE RIVETED 6¾" LAP ⅞" RIVETS
DOUBLE 3½" X 3½" X 8.5 LBS.
KEEL 8" X 2"
BILGE KEEL FROM FRAME 35 TO FRAME 99 OF BULB ANGLE 10" X 3½" X 20.5 LBS.
BILGE KEEL ANGLES 3" X 3" X 7.2 LBS.
BREADTH MOULDED 29'4"
DEPTH MOULDED 19'3"
Marine Engineering

CROSS SECTION OF STEEL SEA-GOING TUG GYPSUM KING.

had by a ladder opening into the steering engine room in the deck house, so that ventilation of these quarters is secured even in very rough weather. Aft of the machinery spaces the lower deck is carried as far as the after watertight bulkhead, to which access is obtained by a hatch in the steel deck above.

The *Gypsum King* has an extensive machinery equipment for a vessel of her class; in fact, she is in these respects a first-class sea-going job. The propelling engines are of the triple expansion type, with cylinders 17 in., 27 in. and 45 in. dia. and 36 in. stroke. The front columns are steel forgings turned, and the back frames are securely bolted to the condenser. The H. P. valve is a piston valve, and the I. P. and L. P. slide valves. All the pumps are independent of the main engine. The engine crank shaft is of steel, built up and fitted with counterbalances. A direct operating steam reversing engine is fitted on the side of the high pressure cylinder and operated from the starting platform below. An independent direct acting air pump of the Worthington type is fitted, and there are also fire, feed, donkey, bilge, sanitary and wrecking pumps of the Worthington make. The circulating pump is of the centrifugal pattern, built by the Morris Machine Works. An independent feed water heater is fitted and piped to take the exhaust from the various auxiliaries. A hand pump and special ash ejector are also included in the equipment below. There are two main boilers of the Scotch type of 60,000 lbs. T. S. steel, designed for 175 lbs. working pressure. Each boiler is 13 ft. dia. and 11 ft. 2 in. long, and contains three corrugated furnaces 39 in. inside dia., set in separate combustion chambers. The stack is double, with an inside diameter of 5 ft. 4 in., and outside diameter of 6 ft. 6 in., the top being 55 ft. 6 in. above the bottom grates. An improved steam jet is fitted for urging the fires when



HULL PLANS OF STEEL TUG GYPSUM KING, BUILT AND ENGINED BY BURLEE DRY DOCK CO., PORT RICHMOND, STATEN ISLAND, N. Y.

needed. The donkey boiler is of the locomotive type, designed for 100 lbs. pressure and is large enough to run all the auxiliary machinery.

Electric lighting is used throughout. A vertical single Forbes engine, 5 in. by 5 in., is coupled direct to a dynamo, and at a speed of 650 revolutions furnishes current to one 8,000 C. P. searchlight and sixty 16 C. P. incandescent lights. There is also a storage battery having a capacity of 70 ampere hours. On the main deck forward there is a powerful Hyde steam windlass capstan. The *Gypsum King* is a strong, powerful vessel, designed for the special purpose of heavy towing rather than for running at speed independently. On her trial trip on Long Island Sound, however, she showed herself to be quite speedy for a vessel of this type, and her machinery worked with really remarkable smoothness. She developed over 1,100 horse power with less than the allowed pressure, and at no time had the engines to be slowed except when ordered from the pilot house. The excellent construction and performance of this vessel has called out favorable comment, especially as steel vessels of this type have hitherto been the product of yards at ports other than New York.

AMERICAN SCHOOLS OF MARINE ENGINEERING.

THE AMERICAN SCHOOL OF CORRESPONDENCE AT BOSTON, MASS.

Founded for the Education and Advancement of the American Mechanic — Courses confined to Steam, Electrical and Mechanical Engineering.

The American School of Correspondence was founded by two wealthy New York men who appreciated the need of better technical training among the American mechanics who could not attend a regular technical school. They saw the possibility of bringing a good course of technical instruction to the ambitious workman by correspondence, and gave liberally of their wealth to establish such a school. It was first organized in New York city; later, however, it was found advisable to transfer the School to Boston, as that city offers unusual advantages as a location for a technical school, being the home of Harvard University, with its great libraries and laboratories, Lawrence Scientific School, which gives the most advanced instruction in engineering; Massachusetts Institute of Technology; Tuft's College, and other well-known institutions.

In 1897 the School was chartered by the Commonwealth of Massachusetts as "an institution of learning in all branches." The work of the School, however, has been confined strictly to the three allied engineering branches—Steam, Electrical and Mechanical. In Steam Engineering the courses are limited to the three main divisions—Stationary, Locomotive and Marine. By thus specializing the directors believe that the School can give the students better and more personal instruction than would be possible were they to attempt a large number of courses. The School is purely an educational institution, founded to "educate and advance the American mechanic," the tuition being within the means of the wage-earner.

The officers and instructors of the School are all men well known in the educational field, and especially fitted for their work. The President, R. T. Miller, Jr., A.M., LL. B., brings to the management of the School wide experience along educational and business lines. The Secretary, George L. Fowler, A.B., M.E., is a consulting engineer and writer. He is a member of the American Society of Mechanical Engineers, and a frequent contributor to the engineering journals. At the head of the Advisory Board of the School is Dr. Robert Grimshaw, widely known as an engineer and machinist, and the author of numerous books relating to steam engineering and machine-shop work. Charles Thom, another member, is chief of the Quadruplex Department of the Western Union Telegraph Company, and is the author of "Telegraphic Connections"; Francis H. Boyer, M.E., is a constructing engineer and an authority on refrigeration, being a lecturer upon that subject at the Massachusetts Institute of Technology. Mr. Boyer is also a member of the American Society of Mechanical Engineers. Amherst W. Belcher, another member of the Board, is connected with the Cornell Steamboat Company.

The regular corps of instructors has been chosen from among the graduates of the leading technical schools, and are all experienced and enthusiastic teachers.

The work of the Instruction Department is carried on by means of bound instruction papers, of which there are from thirty to thirty-six in each course. Accompanying each instruction paper is an examination paper, which the student is required to answer and send to the School for correction and criticism. When this examination paper has been carefully examined and corrected by the instructor it is returned to the student with a certificate showing his proper grade. The corrections, suggestions and criticisms made by the instructor are very essential parts of the system, as they bring the student in close touch with his teacher.

The instruction papers of the School are prepared under the supervision of the most progressive engineers in the country, and in every case represent the best American practice. They are written in simple language and illustrated at every point where an illustration will make the explanation clearer. The inductive method is followed throughout the course, the object of the writers being to lead the student step by step from the simple fundamental principles to the more intricate engineering work.

As before stated, the work of the School is confined exclusively to Steam, Electrical and Mechanical Engineering. In Steam Engineering, special courses are offered in Stationary, Locomotive and Marine Engineering. The Stationary course is designed for engineers, firemen and all others desiring a better theoretical knowledge of Steam Engineering. The Locomotive course meets the needs of all connected with the great railway systems. The course in Marine Engineering, as the name implies, is intended for marine engineers, oilers, firemen and stokers, and others who desire a theoretical knowledge of the subject. This course is naturally one of the most comprehensive and advanced of the courses offered by the School, as the requirements in Marine Engineering are greater and the scope wider than in any allied branch of engineering.

The object of this course is to give students the necessary theoretical training, which, with their practical experience, will fit them for promotion to the highest positions in the service. It might be added that the technical instruction given is more complete than that required by any examiners for the highest grade of marine license.

The following outline of the Marine Engineering course will give an idea of the plan, arrangement and scope of the course: After enrolling, the student is first given four papers on Elementary Mathematics. These are specially prepared for them, and relate to materials and problems in actual practice, as boiler tubes, weights of various parts of machinery, coal burned, horse-power, etc., so that at the very outset the student is constantly acquiring important facts and data regarding engineering.

After Elementary Mathematics comes two papers on Mechanics. Although this subject is not easy to understand, these papers give so full explanations, so many illustrations and examples, that the student should meet with little difficulty. Following Mechanics is a paper on Heat. This subject is usually treated under the head of Mechanics, but as it is so important in the study of

Steam and Steam Engines, a separate pamphlet is devoted to it.

The sciences of Chemistry and Metallurgy then follow. Chemistry is treated briefly and without laboratory work, but the student learns how elements combine, the chemical reactions and facts relating to combustion. In Metallurgy only iron and steel are considered. The various ores, furnaces, materials and operations are fully described and illustrated. Cast iron and wrought iron are thoroughly discussed, with their characteristics and properties. The Bessemer and Open Hearth methods of making steel are illustrated and the properties of the different products considered.

After completing the foregoing work, which is general in its nature, the student begins his actual work on Marine Engineering. The Construction and Design of Boilers is first taken up. The various materials used in boiler work are described, with their uses, qualities and tests. The processes of cutting, planing, drilling, punching and shaping the plates, are discussed with the advantages and disadvantages of punching and drilling. Rivets and riveting follow, the shapes and specifications of rivets, hand and power riveting being the principal points explained. Other details of construction, such as the arrangement of plates and joints, stays, tubes and caulking, are described with numerous illustrations. The design of boilers is illustrated by giving all the steps in designing an ordinary multitubular boiler. The size of all the parts are calculated for capacity and strength; the chimney also is discussed, with a table of sizes. The various types of boilers are next described. Commencing with a brief history of early forms, the student becomes acquainted with horizontal and vertical, fire-tube and water-tube boilers. The locomotive and marine types of boilers are explained briefly at this point. The various fittings and details of boilers in general are discussed, such as furnaces, valves, cocks, gauges, fusible plugs and separators. The feed apparatus, including injectors, pumps and return traps, are described, as is also feed temperature and location of admission. Among the most interesting topics in this connection are corrosion and incrustation, boiler explosions, fuels and setting. The standard code for making boiler trials is given, also cautions and rules regarding the management.

The student in Marine Engineering thus becomes familiar with boilers in general. He then studies the Marine Boiler in particular. The forms, fittings and details are again taken up, but this time only in connection with the marine boiler. Such appliances as salinometers, evaporators and hydrokineters, being peculiar to marine boilers, are here explained. Draft, natural and forced, is given its due importance. Many of the rules of the U. S. Board of Supervising Inspectors of Steam Vessels are stated and explained, as are also those of the British Board of Trade. The management of marine boilers, including rules for building the fire, firing and banking the fire, and repairs, are discussed at length.

After completing the work on boilers, the study of Machine Design is commenced, thus giving variety to the work. Under this subject only the elements are taught, but the principles are of great value to the student. After explaining the properties of materials and the strains in machines, the various fastenings are taken up. Bolts, nuts, keys, cotters and gibs are illustrated by cuts, and the necessary mathematical formulas explained. Under this head the United States standard thread and proportions of bolt heads and nuts, with the common forms of locking devices, are illustrated. Bearings, pedestals, brackets and couplings, with the empirical formulas for the various proportions, are given. Instruction on tooth, belt and rope gearing is full and thorough; the calculation of velocity, ratio and horse-power transmitted being of special importance. Ratchets and pipe joints also receive proper attention.

After having thoroughly mastered the methods of boiler construction and machine design, the student takes up the study of the steam engine proper. As in studying boilers, he first learns the general principles of engines.

Commencing with the inventions of Watt, Savery and Stephenson, the principle of the steam engine is explained as it was developed. In this connection, the laws of the expansion of steam are discussed and also the table of the properties of saturated steam. The parts of the simplest forms of steam engines are then explained and illustrated. Engines are divided into classes, as high and low speed, condensing and non-condensing, horizontal and vertical, etc., and each class is described with its special advantages under various conditions.

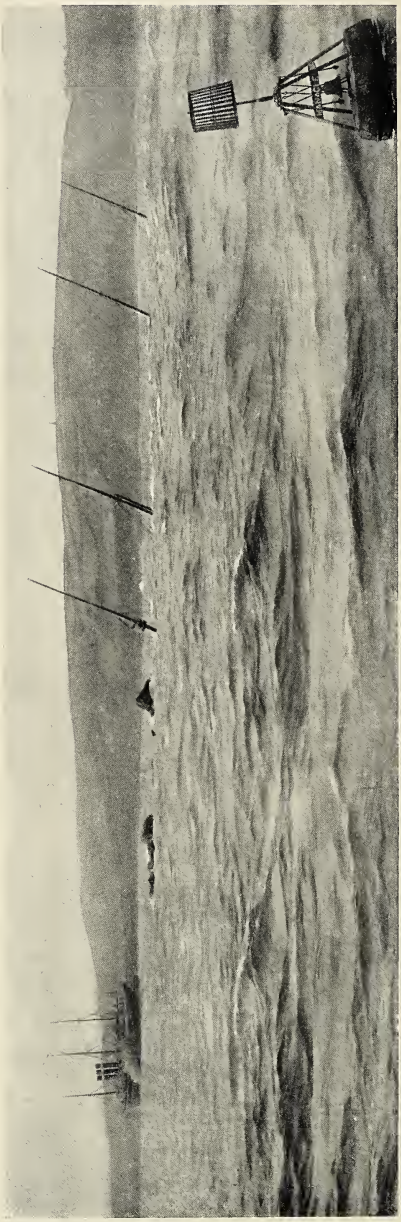
An entire paper is devoted to the study of the Indicator and Indicator Diagrams. This subject is of great importance, especially to the man who has had the practical training of the engine-room, but whose theoretical knowledge is wanting. Three kinds of indicator—the Crosby, Thompson and Tabor—are thoroughly explained, and their peculiarities and advantages pointed out. The theoretical indicator card is discussed with the actual, the differences being explained and the causes of losses pointed out. The methods of finding the area are explained with a cut and description of a planimeter. The cards for compound and triple expansion engines are next taken up; the horse-power computed and the cards combined for the expansion curve. The calcula-

(*Continued on page 124.*)

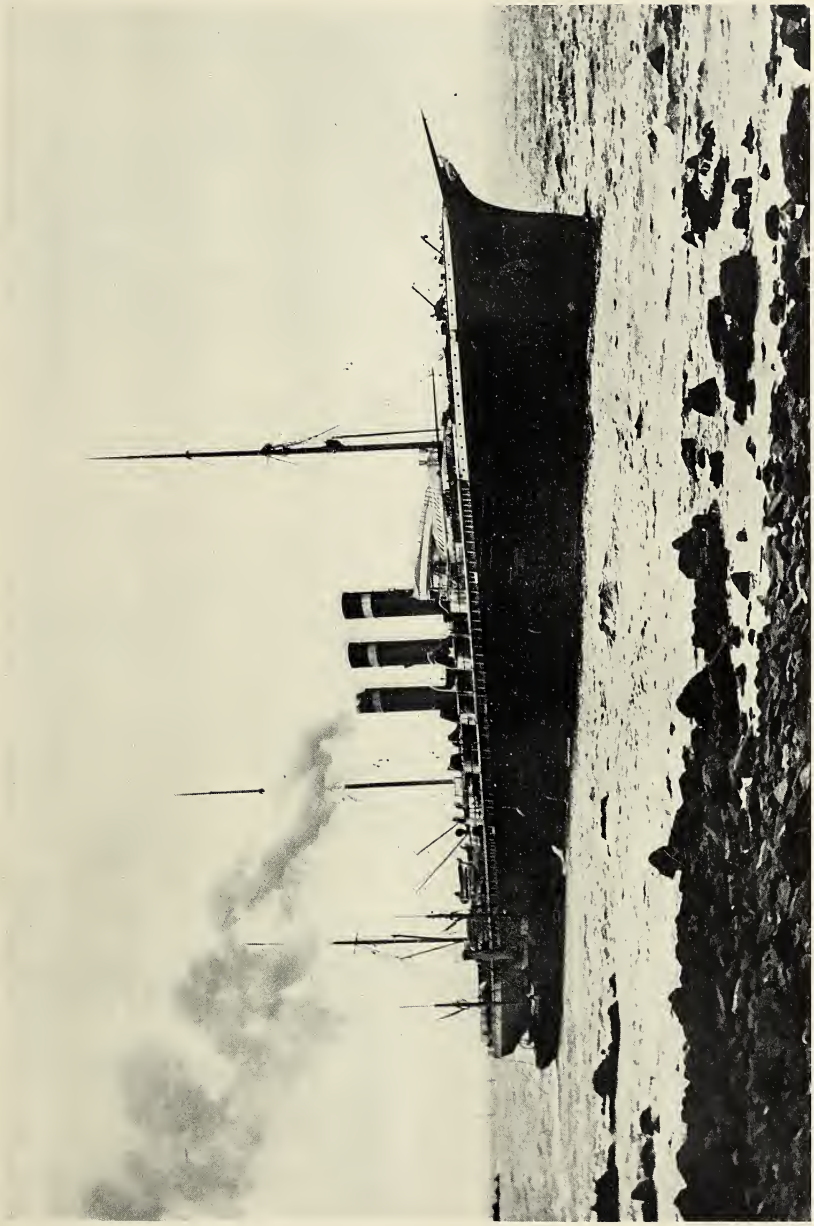
Recent Mishap to the Liner Paris.

In our issue of last month we published an account of the mishap to the former American liner *Paris*, which went ashore on the Manacle Rocks, off Lowland's Point, on the coast of Cornwall. On the two following pages we now publish reproductions of photographs taken on the spot for MARINE ENGINEERING, but which were delayed in transit, and so did not arrive in time for reproduction in our last issue. The position of the *Paris*, both as regards the shore line and the immediately surrounding rocks, can be clearly seen from an inspection of the pictures; and a view which is of special interest is that showing the position of the *Paris* with regard to the wreck of the *Mohegan*, the masts of which can be seen sticking up above the water, and in the foreground the bell-buoy which warns ships away from this dangerous spot. Since the publication of the article in our last issue the vessel is reported as having proceeded under her own steam to Milford Haven, and there gone into dock. Her damages, as we before stated, do not appear to have been as considerable as would be expected by her position so far inshore.

TUGS MAKING AN EFFORT TO PULL OFF THE S.S. PARIS AT HIGH WATER—MAINLAND IN THE FOREGROUND.



S.S. PARIS ASHORE. WRECK OF S.S. MOHEGAN. MANACLES BELL BUOY.



VIEW OF THE TWIN SCREW TRANSATLANTIC STEAMSHIP PARIS ON THE MANACLE ROCKS, SOUTH COAST OF ENGLAND, AT LOW WATER.

Photograph taken for Marine Engineering by W. M. Harrison, Falmouth, England.

tion of the horse-power of engines is simplified by means of a table of engine constants. The faults found in cards, together with the remedies, are pointed out, sample cards being shown for illustration.

The various valve gears, with the Zeuner diagram, are next explained, as are also the various valve gears, among them the Corliss, Meyer and Joy gears. The forms of reversing gear, both for locomotive and marine work, are described.

In the fourth paper on the Steam Engine the various details are taken up. The governor, fly-wheel and lubrication is treated as fully as the space will allow. When the student has reached this point in the course he is in a position to learn something of the theory of the steam engine. Therefore, cylinder condensation, re-evaporation, compounding, jacketing, superheating and lubrication are discussed, showing the causes for loss in efficiency and also the methods taken for prevention.

The Marine Engine is studied last, as was the marine boiler; the requisites, peculiarities and sizes are treated, together with a brief discussion upon the Screw Propeller and the Resistance of Ships. The advantage of the various types under given conditions are stated. A few hints regarding the care, repairing and testing of engines and pumps conclude this subject.

At the present time the marine engineer should know something of Electricity. The course, therefore, includes some elementary work upon the principles of dynamo electric machinery. The work on electric lighting is optional with the student, but on account of its importance it is strongly recommended. Advanced Mathematics are also made optional in the course on Marine Engineering, because the time of many students is limited, and they desire to devote what little they have strictly to engineering.

The work in Mechanical Drawing, which is included in the course, may be taken up at any time. The student is taught the use of drawing instruments, the fundamental principles of drawing, and learns to make working drawings of simple parts of machinery. After completing this he is given a rough sketch of the details of the steam engine, which he is required to draw to scale, and finally to make an assembled drawing.

After having completed the course in Marine Engineering and satisfactorily passed the final examination, the student is awarded a diploma certifying this fact. A diploma from the school is one of the strongest recommendations in securing a better position or an advance in salary.

A distinctive feature of this school is its Special Inquiry Department, conducted by a corps of consulting engineers, who offer to engineers, shop proprietors, superintendents, foremen, as well as to all members of the school the privilege of submitting to them any question in engineering that may trouble them. Such questions are referred to the man most capable of treating them, and the solution is promptly forwarded to the inquirer. When necessary, diagrams are furnished and complete data given.

A careful study of the modern correspondence system will demonstrate how important a factor it is in the education of the wage-earning classes. While it is not claimed that correspondence study is as valuable as regular student life at a university or scientific school, still it places within the grasp of those unable to attend such an institution the substance of a technical education, and lends valuable aid in their effort towards self-culture.

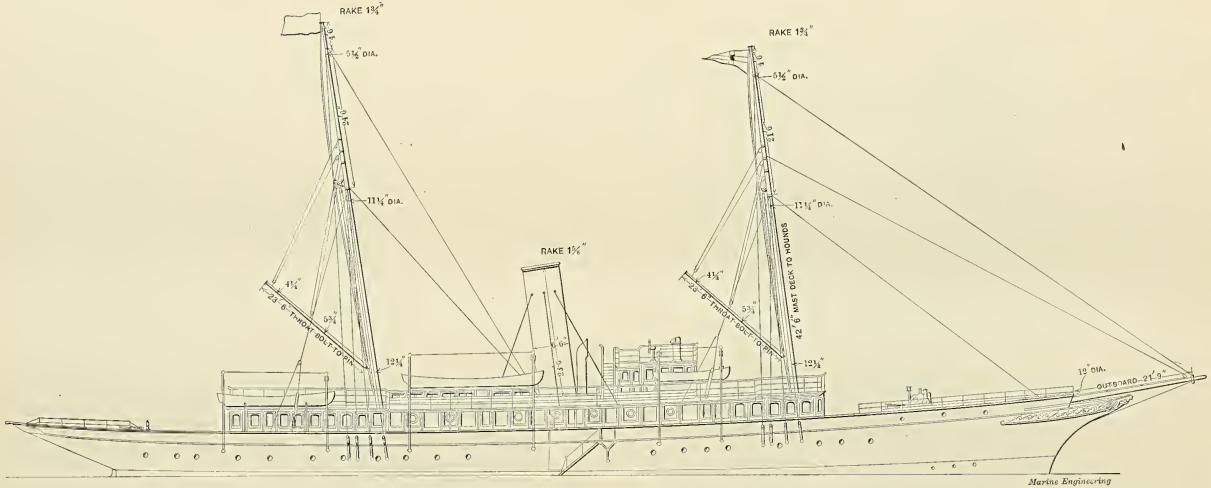
STEEL STEAM YACHT FOR ISAAC STERN BUILT IN U. S. FROM WATSON DESIGN.

A contract has been made between Isaac Stern, of New York, and the Bath Iron Works for the construction of a steel steam yacht, which will probably be named the *Virginia*. This new vessel is being built from a model and sketch plan furnished by Geo. L. Watson & Co., of Glasgow, Scotland; but the builders have prepared the specifications and are working up the design themselves under the supervision of the owner's representative, Mr. Tams, of the firm of Tams & Lemoine, New York.

The new yacht will be a strong, seaworthy, comfortable and handsome vessel. In appearance she will resemble somewhat the steam yacht *Andria*, which was constructed by the Ailsa Shipbuilding Co., of Troon, Scotland, two years ago for John E. Brooks, of New York city, from Watson designs. The *Virginia* will be 165 ft. long on the water line, with a 20 ft. overhang aft and a 15 ft. overhang forward, making the over all length of hull 200 ft. The molded beam is 25 ft. 9 in.; molded depth at side, 15 ft. 4 in.; molded depth at center, 16 ft. 1 in. Height between decks, 7 ft. 6 in., and draught aft, in cruising trim, 12 ft. The scantlings of the yacht are all equal or in excess of the requirements of the British Lloyds and the American Shipmasters' Association, and she will receive the highest classification in the latter society. The vessel has a bar keel and very little deadrise; the midship section being rather full. Notwithstanding this fact the displacement is fairly well proportioned fore and aft, and she carries her bilge well out towards the ends, the bow section being of a most pronounced U form. The full midship section allows a large Scotch boiler of sufficient power to drive the vessel at her designed speed to be placed below the main deck, and by using one large boiler instead of two smaller ones the length of the machinery space is greatly reduced.

The *Virginia* will have a large steel deckhouse handsomely paneled in mahogany 105 ft. long and 14 ft. wide. Between the fore and main rigging the top of this house will be carried out to the side of the vessel, forming a most desirable shade deck. There is a break in the main deck at the collision bulkhead, which is about 30 ft. from the bow, and a forecastle deck will be fitted up to this point at the height of the main rail. Five steel watertight bulkheads will be worked up to the level of the main deck, two watertight bulkheads will stop at the lower deck, and two non-watertight bulkheads will also extend up to the main deck. The main deck is plated with steel for half the length amidships, and steel carefully concealed by the finished woodwork will be worked wherever strength is required. Bilge keels 13 in. deep and 70 ft. long formed of steel plates connected to the hull by a T bar will be worked on each side of the vessel.

Much attention is being given to the vessel in all her



PROFILE OF SINGLE SCREW STEAM YACHT VIRGINIA FOR ISAAC STERN OF NEW YORK—WATSON DESIGN, AMERICAN BUILD.

74062

departments. The cabin arrangement will be ample and luxurious, and the accommodation will comprise every requisite to insure comfort and convenience. All the decorations and fittings will be elegant, efficient and tasteful, and up to the builders' standard for first-class yacht work. The owner's accommodation occupies a space 42 ft. long just forward of the machinery space. Here are located six large staterooms, excluding the maid's room, three toilet rooms and a box room. The staterooms will be finished in white china gloss, with mahogany trimmings. Each room will contain a bed, lounge or transom seat, bureau, chiffonier, wardrobe and the usual smaller portable furniture. The toilet rooms will be paneled and finished in the same style as the staterooms, but a tile dado will extend about 4 ft. above the floor, and the floors will be covered with rubber tiling. In each toilet room a 5 ft. bathtub, w. c. and lavatory will be placed. The plumbing will all be open and nickel plated. Aft of the machinery space there will be three staterooms and a toilet room to be fitted up for the owner's guests. They are known as the "bachelor's quarters," and the finish of these rooms will be in every way equal to that of the owner's forward rooms. Aft of the bachelor's quarters are five staterooms, a w. c., a wardroom and a messroom for the officers. Forward of the collision bulkhead are the crew's quarters. Eighteen berths, a bathroom, washroom and w. c. will be fitted here, also clothes lockers, seats, etc. In the forward part of the deck house is the dining saloon, finished in mahogany,

with sideboard, tables, revolving steamship chairs and all the usual furnishings. Adjoining the dining room is the pantry and a vestibule, from which a stairway leads to the shade deck above. The galley is located between the fire room hatch and the pantry. The main saloon is located abaft the engine hatch, and a passage way inside the deck house connects this saloon with the dining room forward. The saloon will be finished in white gloss with very dark mahogany furnishings. An open fireplace, piano, upholstered transom seats, etc., will make the room very comfortable and homelike. Aft of the main saloon is a deck w. c., a stairway leading below to the bachelor's quarters, a stairway leading below to the officers' rooms and a smoking-room. The latter room will be finished in light oak, natural finish. A small house on the shade deck forward contains the chart room and observation house, and the top of this house extends out to the sides of the vessel forming the navigating bridge. The *Virginia* will be fitted with six boats, viz.: a 26 ft. steam launch, a 25 ft. gig, a 22 ft. lifeboat, a 21 ft. cutter, a 16 ft. and a 14 ft. dinghy. A refrigerating machine will probably be fitted, also a large cold storage chamber. The vessel will have a Williamson steam steerer and a Hyde steam brake windless, with engine under the deck. There will be a modern electric plant on board, with searchlight and a storage battery. The ventilation, steam heat, water service and plumbing will be excellent and complete in all respects.

The spars of the *Virginia* will be lofty, with a pleasing rake and graceful taper. The foremast is 60 ft. high above deck and the mainmast 75 ft. The bowsprit projects 24 ft. outboard and the sliding French gaffs are each 23 ft. long.

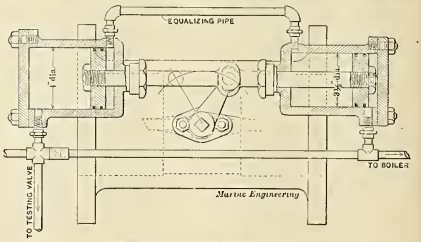
The propelling machinery of the yacht will consist of a vertical triple expansion engine and a steel single ended Scotch boiler. The engine will develop 1,100 I.H.P. with forced draft, and about 650 I.H.P. with natural draft. The cylinders will be 16 in., 26 in. and 41 in. dia., with a stroke of 27 in. The boiler will measure 14 ft. mean diameter and 11 ft. 3 in. long. It will have three Morison suspension furnaces 43 in. dia., with a separate combustion chamber to each furnace. The working pressure will be 180 lbs. The total grate surface provided is 64 sq. ft., and the total heating surface about 2,000 sq. ft. A donkey boiler 4 ft. 6 in. diameter and 10 ft. high, built for a working pressure of 90 lbs., will be fitted.

The designed speed of the *Virginia* is about twelve knots per hour, natural draft, and about fourteen knots per hour, forced draft. It may be of interest to here state that the steam yacht *Andria*, which is fitted with machinery of the same size as the *Virginia*—indeed built from the same engine specification—attained a speed of 14.66 knots per hour, forced draft, on her official speed test. The engine averaged 155 revolutions per min., the steam pressure was 179 lbs., and the I. H. P. about 1,200. The *Andria* is a smaller boat than the *Virginia*, being 4 ft. shorter and a little narrower, but the machinery in the two vessels will be almost identical. The *Virginia* will carry 110 tons of coal and 20 tons of fresh water. She will undoubtedly prove a fast, staunch and comfortable cruiser, yachty and trim in appearance, and a credit to her builders and designers.

IMPROVED APPARATUS.

McLaughlin Safety Stop Valve.

Fatal accidents on board steamships caused by the bursting of steam pipes are frequently reported, and since the very great modern increase in the number of fast-running engines with high pressure steam, in small speedy vessels, a corresponding increase has taken place in the number of fatal accidents caused by the breakdown of engines and the immediate filling up of the engine room with steam direct from the boilers. Numerous safety devices have been exploited for the purpose of checking the flow of steam in pipes in case of mishap. A form of safety stop recently put on the market is that shown in our engraving of the McLaughlin Safety Stop Valve. This is one of the forms in which the valve is applied, here taking the shape of a butterfly valve which is inserted in the steam main. By reference to the drawing it will be seen that on the stem of the butterfly valve an arm is fitted which is connected by a pin to the piston rod. This rod carries a piston on each end, the pistons

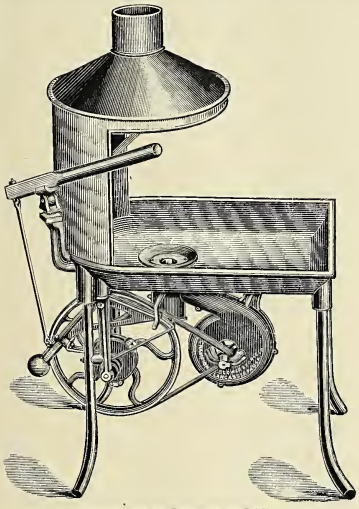


SAFETY STOP ON STEAM MAIN.

being of different diameters. The small cylinder is connected at its back end by a pipe direct to the boiler, while the larger cylinder is similarly connected with, however, an extension of the pipe leading away to various stations for the operation of this valve. A branch also leads from the release pipe to a convenient position where a valve is fitted, so that the engineer may from time to time operate the safety stop by opening the release valve and watching the movement of the piston rod and the arm of the butterfly valve. The operating stations are placed at convenient points where a break might be likely to occur in the pipe system. At each station there is a "safety box," in which there is fitted a valve containing a short section of common water gauge glass, against which a trigger rests. This trigger passes through a small stuffing box in the cover of the safety box, and has a small plate or knob fitted on the end, which can be struck by the hand or foot, according to the location of the box. A by pass is fitted to go around the safety box, which can be used as an alternative method when there is no necessity to shut the safety valve instantly. The manufacturers believe that the breakable glass tube offers a primitively simple and sure means of operation by unskilled persons, who, in the excitement attending a mishap, might forget which way to turn a valve to open or close it. This valve is manufactured by the Barr Pumping Engine Co., Germantown Junction, Philadelphia, Pa. Another form of this safety device is used in connection with the main boiler stop valves.

Portable Lever Forge.

The forge shown in the illustration is specially designed and constructed for the use of machinists and plumbers and for repair work. It is fitted with lever motion of an improved form, which has been applied to many thousand forges with unvarying success. The style shown here is half-hood, but there are many other

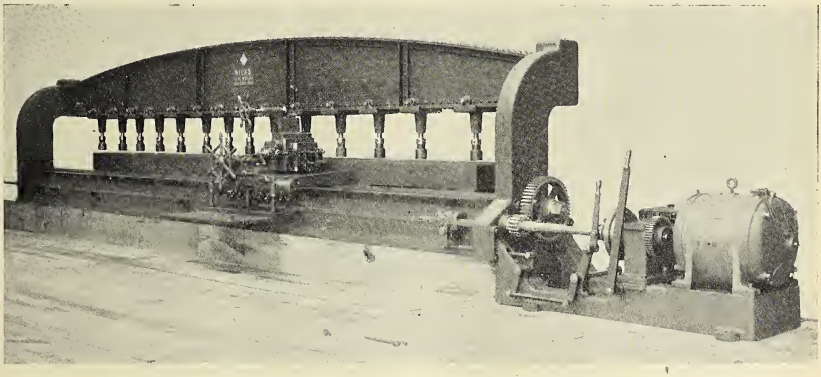


CHAMPION PORTABLE FORGE.

styles suited to special needs. The size of hearth is 23 in. by 35 in. and the fan is 12 in. dia. The height of the forge is 30 in. and the weight 130 lbs. The forge is fitted with the ball tuyere iron and with ball-joint brass oscillating bearings. It is guaranteed to produce a welding heat on 3 in. iron in five minutes. The forge is manufactured by the Champion Blower and Forge Co., Lancaster, Pa.

Heavy Plate Planing Machine.

Our engraving shows a heavy plate planing machine recently constructed by the Niles Tool Works, Hamilton, Ohio, to plane plates 2 in. thick and 25 ft. long with one setting, or any lengths by additional settings. The bed is extra heavy, to which brackets are attached carrying the work table. The work table is provided with T-slots and stop holes. The work is held by trolley jack-screws, which are hung on the flange of a heavy box girder amply stiff to take the thrust of the screws. The housings are secured to the bed by bolts and dowels. The driving screw is of large section, 2 in. pitch and supported for its entire length on the bed. It is provided with ball-bearings at each end for taking up end thrust. The carriage carries two tool slides, one with horizontal movement and the other with both horizontal and vertical motion. One of the tool aprons is constructed as to take a cut in either direction. The reversing is done automatically and very quickly. Provision is made for starting and stopping by hand. The driving mechanism is held on a gear frame rigidly attached to the bed and bolted to the foundation. This machine is driven by an electric direct motor coupled to the driving mechanism. A special automatic controller is used for starting, stopping and reversing the motor, and to protect it under all conditions. The motions of the carriage are governed wholly by the direction of the rotation of the motor, and the power required by the motor is, at all times, exactly proportional to the work done by the machine. The operator controls machine either at the carriage or by lever at the motor. The performance of the motor is entirely independent of the quickness or slowness with which the lever is thrown. On this machine provision was made for pulleys also, and the motor is connected to the driving mechanism by a friction clutch, so that the machine can be driven either electrically or by belt as desired.



HEAVY PLATE PLANING MACHINE, BUILT BY NILES TOOL WORKS CO

CAPTURED SPANISH WAR VESSELS.—Work is progressing rapidly on the reconstruction of the captured Spanish war vessels, *Don Juan de Austria, Isla de Cuba* and *Isla de Luzon*, at Hong Kong. These vessels were damaged chiefly by fire, and after they were raised at Manila they were found to be available for service.

MARINE ENGINEERING

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WITHIN a few days of the publication of this issue, if all goes well, the magnificent new steamship *Oceanic,* of the White Star Line, will arrive in New York harbor. Probably no merchant vessel since the *Great Eastern* has attracted so much attention among marine men and the general public, and this is quite natural, as each vessel represents a more than ordinary advance in dimensions over prevailing practice, and each is the biggest of its day. Indeed, in making comparisons between the *Oceanic* and preceding vessels, the *Great Eastern* has invariably been selected as the vessel of all others which can be best contrasted with the new leviathan. For this reason we have placed before our readers in this issue a memorandum of the chief characteristics of each vessel, accompanied by original and authentic photographs. Putting the vessels side by side, as it were, without any consideration of the magnitude of the problem confronting the respective designers and constructors of the old and new, there are several points which are of interest. At the start it may be said that, so far as published data goes, there is more exact information available concerning the *Oceanic* than the *Great Eastern.* Various authors differ in the particulars of the *Great Eastern* that they give, the cause for this no doubt being the different conditions under which observations were made. The vessel never entered the service for which she was built, and in her active life was engaged in widely differing work. Even while in the transatlantic trade she was not taxed to her full capacity. By comparing the general dimensions of each it will be observed that while the *Oceanic* (704 ft.) is 12 feet longer over all than the *Great Eastern,* she is but 5 feet longer between perpendiculars. The *Great Eastern* was, however, 15 feet wider and 8 ft. 6 in. deeper than is the *Oceanic.* The ratios of length to beam of the vessels are 8.19 for the *Great Eastern* and 10.07 for the *Oceanic.* These dimensions, however, do not entirely regulate the important item of displacement, and it is here that the *Oceanic* gains considerably. Her owners announce that at the load draught, with all cargo, stores and coal aboard ready for sea, she will draw 32 ft. 6 in., and will displace 28,500 tons. This draught is certainly very much greater than what may be called the normal draught of the *Great Eastern,* which on her first transatlantic voyage drew 22 ft. forward and 26 ft. aft. The light draught of the *Great Eastern* is given as about 16 ft., and load draught for her designed service 30 ft., with a maximum displacement of 30,000 tons. Under her actual conditions of service it is probable that the load draught of the *Great Eastern* was less than 26 ft., and her displacement 27,000 tons. There is a considerable difference between the weights of hull of the vessels, the launching weight of the *Oceanic* being somewhere between 10,000 and 11,000 tons, while, from the most authentic accounts at the time, the launching weight of the *Great Eastern* was somewhere between 8,000 and 9,000 tons. The hull of the *Oceanic* is, of course, of tremendous strength, built to carry undisturbed the immensely greater horse power and to make steady progress at speed on the Atlantic even in the roughest weather. Her skin plates are on an average about 1 1-4 in. thick, while those of the *Great Eastern* were only 3-4 in. thick; and again, the systems of framing of the vessels differed very materially. Taken altogether, then, under the actual conditions of service, the *Oceanic* is undoubtedly the "larger" ship, though there is no necessity to magnify her dimensions, and at the same time to minimize those of the *Great Eastern,* a tendency observable in certain quarters. Success brings success, and while the enterprise of the owners and the splendid achievements of the builders of the *Oceanic* are entitled to full and unconditional credit, the similar qualities which those gone before have shown are, comparatively, not overshadowed.

Without the aid of modern material, modern methods and tools, and above all the intervening forty years of experience and scientific advancement, the *Oceanic* could not be the success that she has so far shown herself. The *Oceanic* is timely, the *Great Eastern* was premature. Her designers and builders were far in advance of their times (considering the then possible economies of operation and prevailing conditions of trade), and so long as the science and art of marine construction exist so long will their names remain near the top. Now and again some unconscious (possibly) imitator comes along and claims credit for what long ago these men put in practice. For example, the recent claim by one of the German lines that a projected ship would be the first afloat to have a double skin, while this very idea was one of the merits of the really *Great Eastern*. To equal the achievements of the *Great Eastern's* builders to-day would mean the construction of a vessel of about 1,200 ft. in length, and capable of a sea speed of not less than 30 knots.

ONE development along the line of advanced education which has taken an established place in American educational work is the correspondence school. It may be considered supplemental to the great educational activity of the past quarter of a century in America, which has found expression in the broadening and extension of university work, largely through the liberality of public spirited men. Increased facilities have brought an increasing demand for instruction in the higher branches of knowledge, and especially those of a professional character, which the public or private school must of necessity leave untouched. To secure special university training by personal attendance is usually impossible for the man engaged in practical work, with, often, domestic responsibilities. It is here that the correspondence system becomes indispensable. The facilities for a technical education are carried to the door of the student, no matter where he may reside, and while this has disadvantages, even under these special circumstances, it has at least one marked advantage over instruction in the class room. There the progress of the individual student is governed largely by that of his fellows, while with the correspondence method he receives individual instruction suited to his special needs, so that if diligent his progress is surprisingly rapid. To be sure, the student, unless he be very methodical, is apt to gain knowledge intermittently as he is rid of the call of the class room for regular attendance at specified hours. Here again is advantage and disadvantage. Should he be unable to maintain "regular attendance," as it were, due to unforeseen causes, say overtime or extra work ashore or afloat, he need not resort to bluffing tactics in recitations to keep up with his class, but can make each step deliberately, using such times for study as best suit his occupation. As his work is written, there is small chance for misleading his instructor as to his abilities or information. It should never be forgotten, though, that faithful work is the only sure means of acquiring knowledge, whether by correspondence or by word of mouth. There is no easy way, or rather no absorbent method, of gaining knowledge, but the student must masticate and digest the facts and theories whether he gets them by mail or in the class room. Among practical men there is, unfortunately, too often shown a spirit of intolerance of theoretical discussion, which arises usually from a consciousness of considerable practical knowledge or from mental laziness. The one believes he knows more of the "real" tangible engineering work than can be "learned out of a book," and the other sees, in even a simple formula, an added and unnecessary burden of work. Such men, at some time or another, must stand aside and let the procession of knowledge pass on, and take comfort in their non-success and the success of others by growling about favoritism or a pull. We have been at some pains to present to our readers in several recent issues facts regarding the facilities for technical education in America in our special branch of engineering work, and this month we bring the series to a close. There are to-day, in this country, as good opportunities for securing a scientific training in naval architecture and marine engineering as exist in any country in the world, and better than in any country outside of Great Britain, and we know whereof we write. That the work of the various educational institutions will tell in time in the progress and standing of American shipbuilding and engineering there can be no denial.

THE value of wireless telegraphy at sea was demonstrated under working conditions during the recent British naval manœuvres, reported elsewhere in these pages. At a critical moment a cruiser of one fleet sent a message a distance of about 80 miles back to the flagship, and the fleet was thus able, far in advance of its arrival at a given point, to anticipate the needs of the moment.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—RIVETED JOINTS.

BY DR. WILLIAM FREDERICK DURAND.

The various joints in a boiler are usually of the riveted form. The use of welded joints in various parts of boiler construction is increasing somewhat as greater skill is acquired in making them, but in ordinary practice the joints are riveted, and of various types, as follows:

Riveted joints are divided into *lap* joints and *butt* joints, according as the plates lap over each other (see Figs. 5-8), or butt together at the edges, and are covered by one or two butt straps (see Figs. 9-13). They are also divided according to the number of rows of rivets into *single, double* or *triple* riveted joints (see Figs. 5-7).

The rivets are usually *staggered* in arrangement, as shown in Figs. 6-13. Sometimes, though rarely, the *chain* arrangement, as shown in Fig. 1, is used. While chain riveting is as strong, or perhaps even slightly stronger, than staggered riveting, the latter gives a better disposition of rivets for making a steam or water-tight joint, and this fact leads to its more frequent use in boiler construction. In butt joints the arrangement of rivets is duplicated on each side of the joint, and the style of riveting is named according to the arrangement on one side. Thus, Fig. 9 shows a double-riveted and Fig. 10 a triple-riveted butt joint.

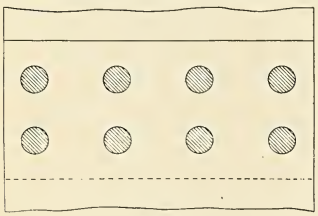

FIG. 1.

A riveted joint may fail: (1) In the plate by tearing out or across from hole to hole, see Figs. 2-3; (2) in the rivet by shearing; (3) in the plate or rivet by a crushing of the material.

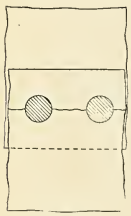

FIG. 2.

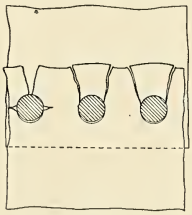

FIG. 3.

The failure of a joint by the tearing out of the plate in front of the rivet, as in Fig. 3, is safely guarded against by placing the row of rivets at a proper distance from the edge of the plate. This, by experience, is found to be about one diameter in the clear, or one and one-half diameters from edge of plate to center line of rivets. In lap joints and butt joints with one cover, as in Fig. 4, the rivets resist shearing at one section only. In butt-joints with double covers, as in Figs. 9-12, the rivets resist shearing at two sections. The total shearing strength of a rivet in double shear is usually taken as somewhat less than twice the strength in single shear. The British Board of Trade rules give 1 3-4 as the ratio to be used.

FIG. 4.

With usual proportions the last mode of failure mentioned above is the least likely to occur, so that so long as the proper limits are not exceeded the resistance to crushing needs no especial examination. These limits will be given in detail at a later point.

The strength of a riveted joint is, of course, determined by whichever is the weaker of the two, the plate or the rivets. In a properly designed joint the strength of the plate and that of the rivets should be equal, so that there will be no more likelihood of failure in one way than the other. It may be remarked, however, that since corrosion usually affects the plate only, it is often considered good practice to give to the plate a slight excess of strength, so that even after some wasting by corrosion the joint may still be in fair proportion as to the relative strength of plate and rivets. No exact directions can be given for this increase, as it is simply a matter of judgment.

The investigation of the strength of riveted joints by any simple theory is necessarily quite imperfect, because we do not know in just what way the stress is distributed through the remaining part of the plate, nor through the section of the rivet, nor what allowance to make for the frictional grip of the joint. The proportions given by the following equations, however, are those which will give practically equal strength of plate and rivets, using the British Board of Trade rules. These rules represent standard and reliable practice, based on wide experience, and are substantially adopted by the United States inspection authorities. In thus considering a joint we take simply an element such as that between AB and CD in the following diagrams. It is clear in each case that the whole joint may be considered as made up of a series of such elements:

Let p denote the *pitch* of the rivets: that is, the distance from center to center. Where the rivets in one row are pitched twice as far apart as in another (see joints D, H, etc.), p denotes the larger of the two values.

" d denote the diameter of rivet.*

" $n = p \div d$ = number of rivet diameters in the pitch.

* NOTE.—Strictly speaking the diameter of the rivet *hole* should be used, as it is about $\frac{1}{16}$ inch larger than the rivet before heading up. In the Board of Trade Rules, however, the diameter of *rivet* is used. The difference in proportion of joint is quite small, and probably not of practical importance.

Let t = thickness of plate.
" $a = t \div d$.
" T = tensile strength of plate per square inch of section.
" S = shearing strength of rivet per square inch of section.

The ratio of S to T is taken as 23 : 28 or $S = .821\ T$.

The *efficiency* of the joint is the ratio between the strength of the joint and the original strength of the plate. It will be seen by the formulæ given later that the efficiency of a joint is increased as d and p are made larger. There is, however, a practical limit to the increase in d, due to the difficulty of heading up very large rivets, and a limit to the increase in p, due to the necessity of guarding against leakage. If the general proportions between d and t, as indicated later in connection with the various joints, are observed, the result will be a pitch within safe limits, and a joint agreeing well with the best practice.

The largest permissible values of the pitch, according to the Board of Trade rules, are given by the following formula:

$$p = C\,t + 1\tfrac{5}{8}$$

where C is drawn from the following table:

Form of Joint as Shown Below.	C	Form of Joint as Shown Below.	C
A	1.31	F	4.63
B	2.62	G	5.52
C	3.47	H	6.00
D	4.14	I	6.00
E	3.50		

In no case should the pitch exceed 10 inches.

We will now proceed with the equations and proportions for various forms of riveted joints.

Joint A — *Lap Joint* — *Single Riveted*

h = $1\frac{1}{2}\ d$

B = $3\ d$

The element is $A\ B\ D\ C$, containing one rivet. We have in this case:

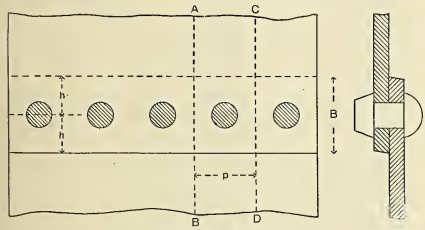

FIG. 5.

Strength of Plate $= t\,(p - d)\,T$

Strength of Rivets $= \frac{1}{4}\pi d^2 S$

For equal strength of plate and rivet,

$$\frac{p}{d} \text{ or } n = 1 + .645\,\frac{d}{t}$$

$$\textit{efficiency} = \frac{n-1}{n} = \frac{.645}{a + .645}$$

The ratio $d \div t$ may vary from 1.5 to 2.5, the lower values being more commonly employed with very thick plates on account of the difficulty of heading up excessively large rivets, and the necessity of a moderate pitch to insure against leakage. In order, furthermore, to guard against danger of rupture by crushing, the upper limit, 2.5, should not be exceeded.

The foregoing operations may be expressed also by the following:

Rule. (1) Select a diameter of rivet according to the thickness of the plate and the directions given.
(2) Multiply this diameter by .645 and divide by the thickness of plate.
(3) Add 1 to the result obtained in (2).
(4) Multiply the diameter of rivet by the result obtained in (3), and the result will be the pitch suited to the diameter chosen.
(5) Select the nearest working dimension, going usually above in order to give slight excess of strength to the plate.
(6) To find strength of plate in the joint, subtract the diameter of rivet from the pitch, multiply by the thickness and by the tensile strength per square inch of section.
(7) To find strength of rivet, find area of section, multiply by the same strength per square inch as in (6), and then by .821.
(8) To find original strength of plate multiply pitch by thickness of plate, and by the tensile strength per square inch, as in (6).
(9) To find the efficiency, divide the lower of the two results found in (6) and (7) by that found in (8).

Example. To lay out a single riveted lap joint for 1-2 inch plates, using 7-8 inch rivets.

$$\text{Then } \tfrac{7}{8} \times .645 \div \tfrac{1}{2} = \frac{7 \times .645 \times 2}{8} = 1.13$$

And 1.13 + 1.00 = 2.13.

And $2.13 \times \frac{7}{8} = 1.86$ = pitch.

Take the nearest eighth above and we have pitch = 1 7-8 inch.

Then taking strength of plate at 60,000 lbs. per square inch, we have:

Strength of Plate in Joint $= (1\frac{7}{8} - \frac{7}{8}) \times \frac{1}{2} \times 6{,}000 =$ 30,000.

Area of $\frac{7}{8}$ inch rivet = .60 sq. in.

Strength of rivet $= .60 \times 60{,}000 \times .821 = 29{,}550$.

Original strength of plate $= 1\frac{7}{8} \times \frac{1}{2} \times 60{,}000 = 56{,}250$.

Efficiency $= 29{,}550 \div 56{,}250 = .525$.

Similarly, if we should take 15-16 inch rivets, we should find for equal strength in plate and rivet a pitch of 2.07 inches. If we take a pitch of 2 1-8 inches we shall find an efficiency of .533. If we take the 2.07 exact the efficiency will be .548.

Joint B. — *Lap Joint.* — *Double Riveted.*

$h = 1\frac{1}{2}\ d$

q not less than $(.6\ p + .4\ d)$

Hence H not less than $\sqrt{(1.1\ p + .4\ d)(.1\ p + .4\ d)}$

$B = 3\ d + H$

Where there are two or more rows of rivets they must be placed at a sufficient distance apart, so that there may be no danger of rupture along a zig-zag line, as indicated in the diagram. To this end the British Board

of Trade rules give certain values for the distance q as given before for this case. This distance is known as the *diagonal pitch*. The rules are derived from experiment. The distances resulting may be considered as the smallest allowable. In practice the values of q are often made somewhat greater than would result from the rules. Having selected the distance q, the location of the second row of rivets is easily found from the first by constructing a triangle with base equal to p, and the two other sides each equal to q. See Chap. I. (October issue, 1898).

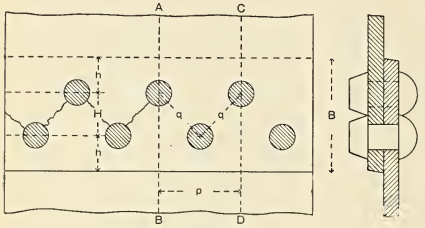

FIG. 6.

In this case the element $A\ B\ D\ C$ contains one whole rivet and two halves, or two rivets in all. We have then:

$$Strength\ of\ Plate = t\ (p - d)\ T$$
$$Strength\ of\ Rivets = \tfrac{1}{2}\pi d^2 s$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 1.29\,\frac{d}{t}$$

$$\text{efficiency} = \frac{n-1}{n} = \frac{1.29}{a + 1.29}$$

The values of $d \div t$ may vary through about the same range as in joint A, above, and for the same reasons as there explained. These operations may be expressed by a rule similar to that for joint A, the numbered sections referring to that rule as given above:

Rule:

(1) Same as for joint A.

(2) Use 1.29 instead of .645.

(3), (4), (5), (6) Same as for joint A.

(7) Take twice the strength of one rivet, found as for joint A.

(8), (9) Same as for joint A.

Example. To lay out a double riveted lap-joint for 1-2 inch plates, using 3-4 inch rivets.

$$\text{Then } \tfrac{3}{4} \times 1.29 \div \tfrac{1}{2} = \frac{3 \times 1.29 \times 2}{4} = 1.935$$

And 1.935 + 1.00 = 2.935

And $2.935 \times \tfrac{3}{4} = 2.201$ = pitch.

Taking the nearest eighth above we have $p = 2\ 1\text{-}4$ inches.

Then taking strength of plate at 60,000, we have:

Strength of plate in joint = $(2\tfrac{1}{4} - \tfrac{3}{4}) \times \tfrac{1}{2} \times 60{,}000$ = 45,000.

Area of 3-4 inch rivet = .4418 sq. in.

Strength of rivets = $.4418 \times 2 \times 60{,}000 \times .821 = 43{,}520$.

Original strength of plate = $2\tfrac{1}{4} \times \tfrac{1}{2} \times 60{,}000 = 67{,}500$.

Efficiency = $43{,}520 \div 67{,}500 = .645$.

Similarly with 7-8 inch rivets, pitched 2 7-8 inches, the strength of plate and rivets will be nearly equal, and the efficiency will rise to .687.

Joint C. Lap Joint. Triple Riveted.

$$h = 1\tfrac{1}{2}\ d$$

q not less than $(.6\ p + .4\ d)$

Hence H not less than $\sqrt{(1.1\ p + .4\ d)(.1\ p + .4\ d)}$

$$B = 3\ d + 2\ H$$

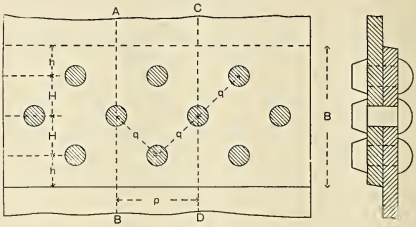

FIG. 7.

In this case the element $A\ B\ D\ C$ contains two whole rivets and two halves, or three rivets in all. We have then:

$$Strength\ of\ Plate = t\ (p - d)\ T$$
$$Strength\ of\ Rivets = \tfrac{3}{4}\pi d^2 S$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 1.935\,\frac{d}{t}$$

$$\text{Efficiency} = \frac{n-1}{n} = \frac{1.935}{a + 1.935}$$

The values of $d \div t$ may vary through about the same range as in joint A, above, and for the same reasons as there explained. These operations may be expressed by a rule similar to that for joint A, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint A.

(2) Use 1.935 instead of .645.

(3), (4), (5), (6) Same as for joint A.

(7) Take three times the strength of one rivet found as for joint A.

(8), (9) Same as for joint A.

Example. To lay out a triple-riveted lap-joint for 1-2 inch plates, using 3-4 inch rivets.

$$\text{Then } \tfrac{3}{4} \times 1.935 \div \tfrac{1}{2} = \frac{3 \times 1.935 \times 2}{4} = 2.903$$

And 2.903 + 1.00 = 3.903

And $3.903 \times \tfrac{3}{4} = 2.93$ inches = pitch.

Take $p = 3$ inches.

Then taking strength of plate at 60,000, we have:

Strength of plate in joint = $(3 - \tfrac{3}{4}) \times \tfrac{1}{2} \times 60{,}000 = 67{,}500$.

Area of 3-4 inch rivet = .4418.

Strength of rivets = $.4418 \times 3 \times 60{,}000 \times .821 = 65{,}280$.

Original strength of plate = $3 \times \tfrac{1}{2} \times 60{,}000 = 90{,}000$.

Efficiency = $65{,}280 \div 90{,}000 = .725$.

Similarly with 7-8 inch rivets, pitched 3 7-8 inches, the efficiency becomes .764.

Joint D. Lap Joint.

Triple Riveted, with rivets in inner row spaced one-half p.

$$h = 1\tfrac{1}{2}\ d$$

q not less than $(.3\ p + d)$

Hence H " " " $\sqrt{(\tfrac{11}{20}\ p + d)(\tfrac{1}{20}\ p + d)}$

$$B = 3\,d + 2\,H$$

As seen below, the efficiency of this joint is superior to that of joint *c*, but it is perhaps slightly inferior as

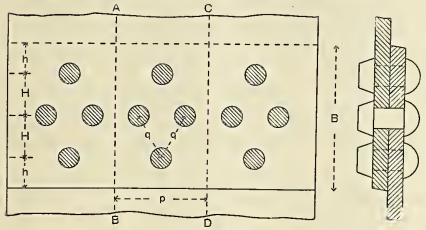

FIG. 8.

regards tightness against leakage. We have in this case:

$$\textit{Strength of Plate} = t\,(p - d)\,T$$
$$\textit{Strength of Rivets} = \pi d^2\,S$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 2.58\,\frac{d}{t}$$

$$\text{efficiency} = \frac{n-1}{n} = \frac{2.58}{a + 2.58}$$

The values of $d \div t$ may vary through about the same range as in joint *A*, above, and for the same reasons as there explained. These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 2.58 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take four times the strength of one rivet found as for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a triple-riveted joint as in *D* for 1-2 inch plates, using 3-4 inch rivets.

Then $\frac{3}{4} \times 2.58 \div \frac{1}{2} = \frac{3 \times 2.58 \times 2}{4} = 3.87$.

And $3.87 + 1.00 = 4.87$.

And $4.87 \times \frac{3}{4} = 3.65$ inches = pitch.

Take $p = 3$ 11-16 inches.

Then $\frac{1}{2}\,p = 1$ 27-32 inches.

Then taking strength of plate at 60,000 we have:

Strength of plate in joint $= (3\frac{11}{16} - \frac{3}{4}) \times \frac{1}{2} \times 60{,}000 =$ 88,125.

Area of 3-4 inch rivet = .4418.

Strength of rivets $= .4418 \times 4 \times 60.000 \times .821 = 87{,}050$.

Original strength of plate $= 3\frac{11}{16} \times \frac{1}{2} \times 60{,}000 = 110{,}625$.

Efficiency $= 87{,}050 \div 110{,}625 = .787$.

With 7-8 inch rivets spaced 2 7-16 inches in the middle row and 4 7-8 in the outer rows, the strength of plate and rivets would be nearly equal, and the efficiency would rise to .81.

Joint E. *Double Butt-Straps.*
Double Riveted.

$h = 1\frac{1}{8}\,d$

q not less than $(.6\,p + .4\,d)$

Hence H " " " $\sqrt{(1.1\,p + .4\,d)(.1\,p + .4\,d)}$

$B = 6\,d + 2\,H$

Thickness of each butt strap not less than 5-8 the thickness of plate.

The arrangement of rivets is duplicated on either side of the joint line *P Q*. We need only to investigate the part of the joint on one side of *P Q*. The element is then *A B D C*, as in joint *B*, except that the rivets are in

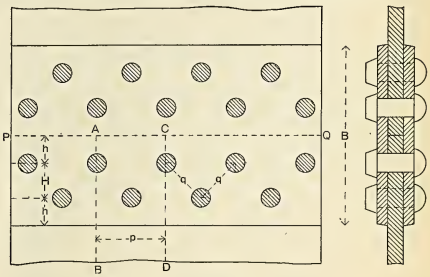

FIG. 9.

double shear instead of *single* shear. For the total shearing strength of a rivet in double shear, as previously explained, it is customary to take 1 3-4 times the strength for single shear instead of 2 times, or to take the two strengths in the ratio 7 : 4.

We then have:

$$\textit{Strength of Plate} = t\,(p - d)\,T$$
$$\textit{Strength of Rivets} = \tfrac{7}{8}\pi d^2 S$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 2.26\,\frac{d}{t}$$

$$\text{Efficiency} = \frac{n-1}{n} = \frac{2.26}{a + 2.26}$$

In all double butt strap joints $d \div t$ usually varies from 1 to 1 1-4. The lower range of values, as compared with joints in which the rivets are in single shear, is required in order to insure the joint against danger of failure by crushing.

These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 2.26 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take 3 1-2 times the strength of one rivet, as found for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a joint as in *E* for 1 inch plates, using 1 1-8 inch rivets.

Then $1\frac{1}{8} \times 2.26 \div 1 = \frac{9 \times 2.26}{8} = 2.54$.

And $2.54 + 1 = 3.54$.

And $3.54 \times \frac{9}{8} = 3$ 98 inches = pitch.

Take pitch = 4 inches.

Then taking strength of plate at 60,000 lbs., as before, we have:

Strength of plate in joint $= (4 - 1\frac{1}{8}) \times 1 \times 60{,}000 =$ 172,500

Area of 1 1-8 inch rivet = .994.

Strength of rivets $= .994 \times 3\frac{1}{2} \times 60{,}000 \times .821 = 171{,}350$.

Original strength of plate $= 4 \times 1 \times 60{,}000 = 240{,}000$.

Efficiency = 171,350 ÷ 240,000 = .714.

Similarly with 1 inch plates and 1 1-4 inch rivets, pitched 4 3-4 inches, the strength of plate and rivets will be about the same, and the efficiency is .737.

Joint F. *Double Butt Straps. Triple Riveted.*

$h = 1\frac{1}{2}\ d$

q not less than $(.6\ p + .4\ d)$

Hence H " " " $\sqrt{(1.1\ p + .4\ d)\ (.1\ p + .4\ d)}$

$B = 6d + 4H.$

Thickness of each butt-strap not less than 5-8 the thickness of plate.

The element of the joint is *A B D C*, as in joint *C*, except that the rivets are in double shear. Taking, as

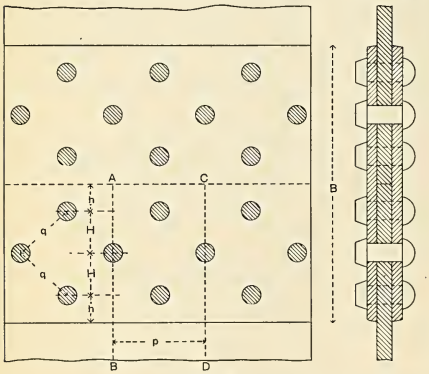

FIG 10.

before, the strength in double shear to that in single in the ratio 7 : 4, we have:

Strength of Plate $= t\ (p - d)\ T$

Strength of Rivets $= 2\frac{1}{16}\ \pi d^2\ S$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 3.39\ \frac{d}{t}$$

$$\text{Efficiency} = \frac{n-1}{n} = \frac{3.39}{a + 3.39}$$

In this joint $d \div t$ usually varies from 1 to 1 1-4, as explained for joint *E*. These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 3.39 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take 5 1-4 times the strength of one rivet, as found for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a joint as in *F* with 1 inch plates, using 1 3-16 inch rivets.

Then $1\frac{3}{16} \times 3.39 \div 1 = \frac{19 \times 3.39}{16} = 4.03$

And 4.03 + 1 = 5.03.

And $5.03 \times 1\frac{3}{16} = 5.97$ inches = pitch.

Take pitch = 6 inches.

Then with strength of plate at 60,000, as before, we have:

Strength of plate in joint $= (6 - 1\frac{3}{16}) \times 1 \times 60{,}000 =$ 288,750.

Area of $1\frac{3}{16}$ inch rivet = 1.108.

Strength of rivets $= 1.108 \times 5\frac{1}{4} \times 60{,}000 \times .821 = 286{,}500$

Original strength of plate $= 6 \times 1 \times 60{,}000 = 360{,}000.$

Efficiency = 286,500 ÷ 360,000 = .796.

Joint G. *Double Butt Straps. Rivets as in Joint D.*

$h = 1\frac{1}{8}\ d$

q not less than $(.3\ p + d)$

Hence H " " " $\sqrt{(.55\ p + d)(.05\ p + d)}$

$B = 6\ d + 4\ H$

Butt-straps to be of thickness not less than as given by the formula:

$$\text{Thickness of strap} = \frac{5\ (p-d)}{8\ (p-2d)} \text{ (thickness of plate)}$$

The element of the joint is *A B D C*, as in joint *D*, except that the rivets are in double shear. Taking, as

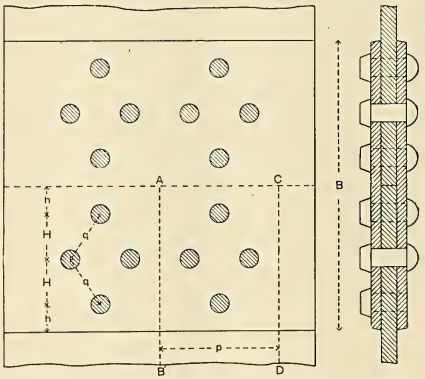

FIG. 11.

before, the strength in double shear to that in single shear in the ratio 7 : 4, we have:

Strength of Plate $= t\ (p - d)\ T$

Strength of Rivets $= \frac{7}{4}\ \pi d^2\ S$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 4.52\ \frac{d}{t}$$

$$\text{Efficiency} = \frac{n-1}{n} = \frac{4.52}{a + 4.52}$$

In this joint $d \div t$ usually varies from about 1 to 1 1-4, as explained for joint *E*. These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 4.52 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take 7 times the strength of one rivet, as found for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a joint as in *G* with 1 1-2 inch plates, using 1 5-8 inch rivets.

Then $1\frac{5}{8} \times 4.52 \div 1\frac{1}{2} = \frac{13 \times 4.52 \times 2}{8 \times 3} = 4.9$

And $4.9 + 1 = 5.9$.

And $5.9 \times 1\ 5\text{-}8 = 9.6$ inches = pitch.

Take pitch for outer rows 9 5-8 and for inner rows $4\frac{13}{16}$.

Then, with strength of plate at 60,000, we have:

Strength of plate in joint $= (9\frac{5}{8} - 1\frac{1}{2}) \times 1\frac{1}{2} \times 60{,}000 =$ 731,250.

Area of 1 1-2 inch rivet = 2.074.

Strength of rivets $= 2.074 \times 7 \times 60{,}000 \times .821 = 715{,}200$.

Original strength of plate $= 9\frac{5}{8} \times 1\frac{1}{2} \times 60{,}000 = 866{,}250$.

Efficiency $= 715{,}200 \div 866{,}250 = .826$.

Joint H. *Double Butt-Straps. Triple Riveted, with double spacing in outer row on each side.*

$h = 1\frac{1}{2}\ d$

q not less than $.3\ p + .4\ d$

q_1 " " " $.3\ p + d$

Hence H " " " $\sqrt{(.55\ p + .4\ d)\ (.05\ p + 4\ d)}$

" H_1 " " " $\sqrt{(.55\ p + d)\ (.05\ p + d)}$

$B = 6\ d + 2\ H + 2\ H_1$

Thickness of butt-straps found by same formula as for joint *G*.

The element of the joint is *A B D C*, containing four whole rivets and two halves, or five in all. These are all

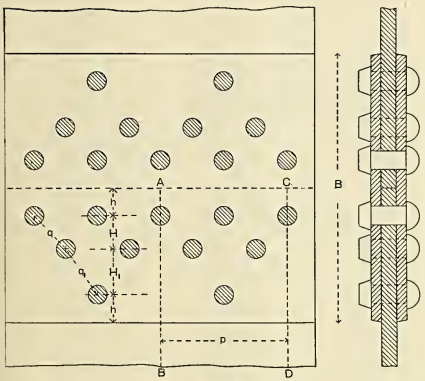

Fig. 12.

in double shear. Taking, as before, the strength in double shear to that in single in the ratio 7 : 4, we have:

$$\text{Strength of Plate} = t\ (p - d)\ T$$

$$\text{Strength of Rivets} = \tfrac{35}{16}\ \pi\ d^2\ S$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 5.64\ \frac{d}{t}$$

$$\text{Efficiency} = \frac{n - 1}{n} = \frac{5.64}{a + 5.64}$$

In this joint $d \div t$ usually varies from 1 to 1 1-4, as explained for joint *E*. These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 5.64 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take 8 3-4 times the strength of one rivet, as found for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a joint as in *H* with 1 3-8 inch plates, using 1 7-16 inch rivets.

Then $1\frac{7}{16} \times 5.64 \div 1\frac{3}{8} = \dfrac{23 \times 5\ 64 \times 8}{16 \times 11} = 5.9$

And $5.9 + 1 = 6.9$.

And $6.9 + 1\frac{7}{16} = 9.92$ inches = pitch.

The limiting pitch by the Board of Trade rule for this case would be 9.87. This means that a pitch of 9.92 or larger would not be passed without special permission. If necessary to reduce below the limit, the joint should be redesigned with a smaller rivet. This case illustrates the point that these limiting values of the pitch, if rigidly adhered to, would prevent the attainment of the best joint efficiencies with thick plates. We shall here assume the right to proceed with the pitch derived from the formula which we will take as 10 inches for the outer and 5 inches for the inner rows.

Then taking strength of plate at 60,000 we have:

Strength of plate in joint $= (10 - 1\frac{7}{16}) \times 1\frac{3}{8} \times 60{,}000 =$ 706,400.

Area of $1\ \frac{7}{16}$ inch rivet = 1.623.

Strength of rivets $= 1.623 \times 8\frac{3}{4} \times 60{,}000 \times .821 =$ 699,600.

Original strength of plate $= 10 \times 1\frac{3}{8} \times 60{,}000 = 825{,}000$.

Efficiency $= 699{,}600 \div 825{,}000 = .848$.

Joint I. *Double Butt-Straps. Triple riveted, outer row on each side being double spaced, and passing through inside butt-strap only.*

$h = 1\frac{1}{2}\ d$

q not less than $.3\ p + .4\ d$

q_1 " " " $.3\ p + d$

Hence H " " " $\sqrt{(.55\ p + .4\ d)\ (.05\ p + .4\ d)}$

" H_1 " " " $\sqrt{(.55\ p + d)\ (.05\ p + d)}$

$B = 6\ d + 2\ H$

$B_1 = 6\ d + 2\ H + 2\ H_1$

Thickness of butt-straps found by same formula as for

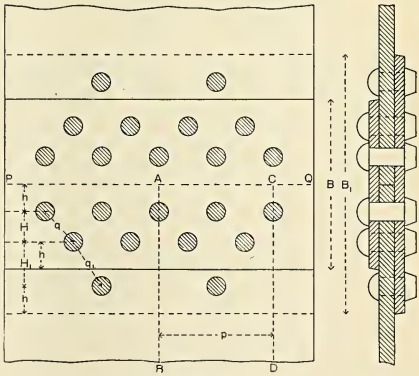

Fig. 13.

joint *G*. The element of this joint is *A B D C*, with four rivets in double shear and one in single shear. Taking,

as before, the strength in double shear to that in single in the ratio 7 : 4, we have:

$$Strength\ of\ Plate = t\,(p - d)\,T$$
$$Strength\ of\ Rivets = 2\,\pi d^2\,S$$

For equal strength of plate and rivets we have:

$$\frac{p}{d} \text{ or } n = 1 + 5.16\,\frac{d}{t}$$

$$\text{Efficiency} = \frac{n-1}{n} = \frac{5.16}{a + 5.16}$$

In this joint $d \div t$ usually varies from 1 to 1 1-4, as explaincd for joint *E*. These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 5.16 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take 8 times the strength of one rivet, as found for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a joint as in *I* with 1 3-8 inch plates, using 1 7-16 inch rivets.

$$\text{Then } 1\tfrac{7}{16} \times 5.16 \div 1\tfrac{3}{8} = \frac{23 \times 5.16 \times 8}{16 \times 11} = 5.40$$

And 5.40 + 1 = 6.40.

And 6.40 × $1\frac{7}{16}$ = 9.2 inches = pitch.

We will take 9 1-4 for pitch of outer row, and hence 4 5-8 for pitch of inner rows. Then, taking strength of plate at 60,000, we have:

Strength of plate in joint = $(9\frac{1}{4} - 1\frac{7}{16}) \times 1\frac{3}{8} \times 60{,}000 =$ 644.530.

Area of $1\frac{7}{16}$ inch rivet = 1.623.

Strength of rivets = 1.623 × 8 × 60,000 × .821 = 639,600.

Original strength of plate = $9\frac{1}{4} \times 1\frac{3}{8} \times 60{,}000 = 763{,}125$.

Efficiency = 639.600 ÷ 763,125 = .838.

An examination of the values of the efficiency will show that these various joints for the same value of $d \div t$ stand, in this respect, in the order:

H, I, G, F, D, E, C, B, A.

THE ART OF MAKING MECHANICAL SKETCHES —FOR MARINE ENGINEERS—IX.

BY PROF. C. W. MAC CORD.

It has previously been stated that in making a drawing in which certain parts are cut by a given plane, it is not always necessary or even advisable to show in section other parts through which that plane would pass. This is further illustrated in Fig 38, which shows the lower part of a horizontal cylinder upon which is cast a supporting bracket, consisting of a foot-plate, connected with the cylinder barrel by two vertical webs at right angles to each other. At the end of the cylinder there is also a hub, which is drilled and tapped for a drain-cock. Clearly, the thickness of the barrel and the size of the flange are best shown by a section, the cutting plane being vertical and passing through the axis, which is parallel to the paper. Such a plane would pass through both the longitudinal web of the bracket and the hub. Were those parts shown in section, however, the support would at first glance present the appearance of a solid mass, as though it were formed by turning in a lathe (a form sometimes adopted), and the impression would be given that the *cylinder* was to be of great thickness just back of the flange, which again is not an impossible construction. Of course, by the use of dotted lines, the actual intention could be expressed; but by no means as clearly as it is in the figure. And this illustrates a rule to which there are few exceptions, viz.: that *a web parallel to the paper should not be shown in section,* even though a plane cutting other parts which must be so represented should be so situated as to pass through the web.

The structure of the bracket is shown by a sectional top view below it, the cutting plane being *m m,* and the form of the hub by a similar section through *n n.*

Reasoning very similar applies in the case of the hand-wheels shown in Fig 39, the upper one having four straight arms, and the lower three curved ones. It will be noted that the sectional view is the same for both, and that if *l l* be the cutting plane, it is not a rigidly correct representation of either. But it does show exactly what the workman wants to know, viz., the forms of the sections of the rim and the hub, and the thickness of the arms at their outer and inner ends; the breadth and the

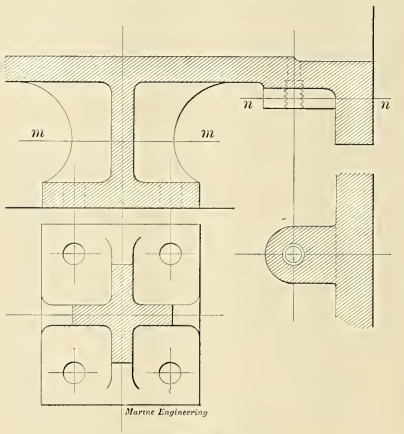

FIG. 38.

shape of the arms being shown in the other views. And this information is all that the sectional view *can* give that is of any practical value; and it is given more clearly and directly by making it as here shown than in any other way. An accurately constructed section by the plane *l l* would, in the case of the straight-armed wheel, look as though the rim and hub were connected by a solid web instead of by arms; and in the case of the other it would convey no information at all, except that the draughtsman presumably knew how to construct the section.

Since the arms *have* sensible thickness, they will in the end views either intersect or be tangent to the rims in curves, as *a b;* if the outer ends of the arms are filleted, these will be curves of tangency, and as imaginary lines not strictly entitled to representation; but it needs no argument to show that their introduction not only adds to the finish of the drawing but aids in giving a conception of the thickness of the arms. In a word.

they are useful, whether imaginary or not, and this practical value overrides theoretical abstractions. This mode of representation, it may be added, is applicable in other cases; thus, a pulley should always be cut at one side of an arm, and a gear wheel not only between two arms but between two teeth, whether an arm or a tooth does or does not lie so that the principal cutting plane passes through it.

In relation to the curved-arm wheel, it may be noted that the approximately elliptical form of the section of

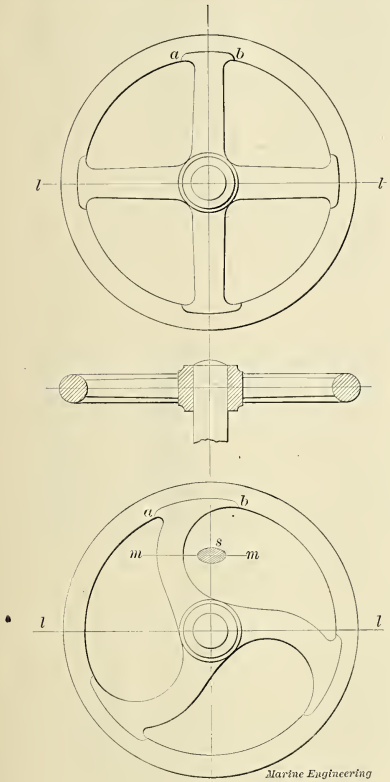

Fig 39.

the arm is shown at *s*, as if a thin slice were cut from the arm at *m m*, moved a little to one side, and revolved about its longer axis into the plane of the paper. A very common method is to draw this section directly upon the arm itself, but since this produces the same effect as though a side projection of that form were made upon the arm, the mode of representation shown in the figure is to be preferred.

In Fig. 40 there is given a working drawing of a small stuffing-box, with its gland and bolts. The form of the gland is clearly defined in the top view, and the case obviously requires a section of the stuffing-box by the plane *l l*, which accordingly is made in the figure. But in the side view, a section by this plane would not be perfectly explanatory, because it would be the same as though the flange of the gland, as well as that of the stuffing-box, were circular. But this is not the case; the gland is stiffened at its upper end by a narrow flange, out of which extend two lugs of the same thickness, through which the bolts pass. In order to convey in the

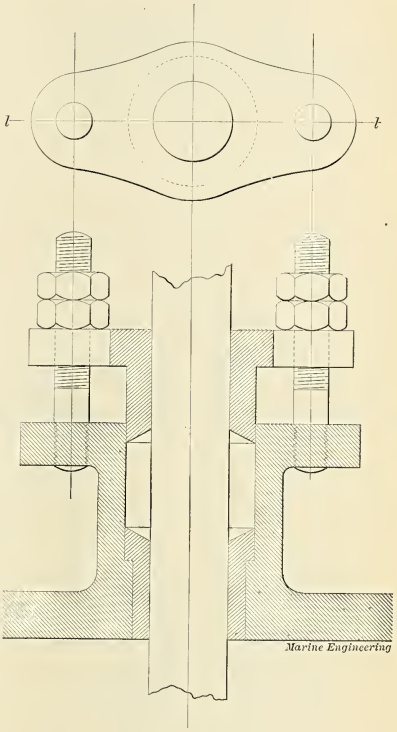

Fig. 40.

clearest manner the nature of this structure in the side view, a section of the gland and its flange by a plane perpendicular to *l l* is drawn, and the lugs and the bolts are shown in elevation.

This exhibits, in a more pronounced manner than any previous illustration, a disregard of the strict laws of making sections and projections. For these laws, when they interfere with practical utility, it will have been perceived that the present writer has a deep and well-founded contempt; the be-all and the end-all of a work-

ing plan is summarily comprehended in these two requirements, viz.:

1. That each view shall show as clearly as possible all that it can be made to show, *and no more than it can show clearly.*
2. That the drawing as a whole shall show what is to be made, *without the possibility of error.*

Applying this test, it is obvious that Fig. 40 satisfies both conditions; no mechanic, with this drawing before

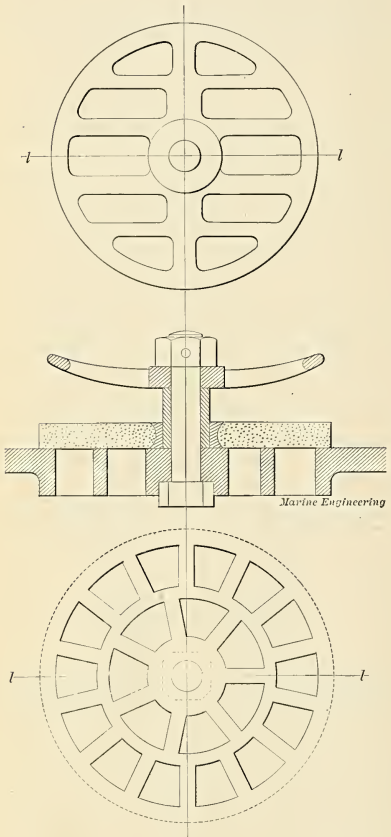

Fig. 41.

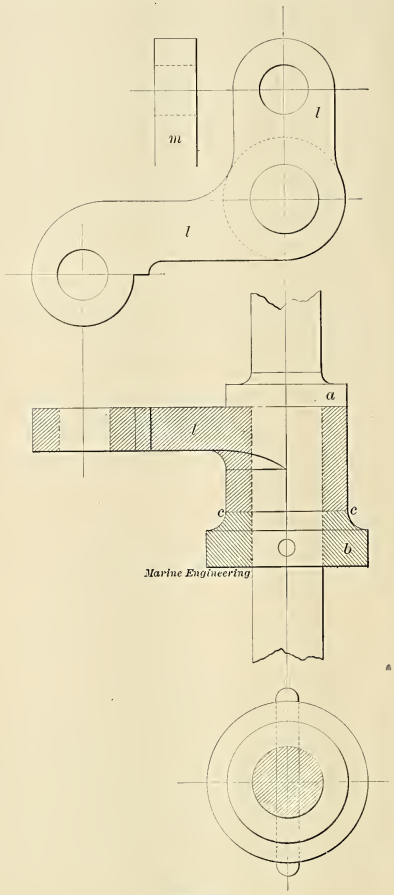

Fig. 42.

him, would be able to retain his position if he made a mistake.

Fig. 41 is a working drawing of a rubber pump-valve, with its central spool, sleeve, bolt, guard and grated valve-seat. The central figure is a section of all except the bolt and nut, by the vertical plane indicated by *l l* in the two top views. In regard to the valve-seat shown below the section, it is to be noted that on the right-hand side the plane *l l* cuts through one of the inner radial ribs; which, nevertheless, is *not* shown in section in the central view—in accordance with the principle or general rule mentioned in connection with Fig. 38. In this lower view the form of the head of the bolt, which is merely a square with the corners cut off, is distinctly shown, and corresponds exactly with the side view in the section. In relation to this drawing, particular attention is called to the fact that separate top views are given of the valve-seat and the guard. It is a melancholy, but still a too common sight, to see a single top view made to do service for both these; the hexagonal nut and the octagonal head of the bolt being drawn (the latter in dotted lines), the valve indicated by a full circle, above

which the guard appears in full outline, while the sleeve, the spool, and the grated seating are shown, or rather obscured, by being drawn in dotted outline. The result is a small saving in the size of the drawing, at the expense of much confusion of lines and difficulty in reading the plan. This amounts to a small saving at the spigot and a large loss at the bunghole, as any "doubting Thomas" may easily convince himself by making the trial.

Fig. 41 also calls attention to this fact, that the circumstances of several pieces being shown in their proper relative positions in one view (in this instance the sectional one), is not an imperative nor always even a good reason why they should be so shown in other views. This is further illustrated in Fig. 42. We have here a portion of a vertical shaft, upon which is formed a collar, *a;* upon this shaft turns freely a bent lever, *l l,* kept in place by a "loose collar," *b,* which is pinned to the shaft. These three elements are shown in position in the central side view; but it is obvious that an attempt to represent this combination by a single top view would be anything but explanatory. A top view of the bent lever is shown above, and a side view, *m,* of the remote arm is also given, in order to show that its thickness is the same as that of the arm which points to the left; this is because the attempt to dot this in, in the side view below, would be very confusing, if not wholly unintelligible.

In this side view, it is to be noted, the formation of the lever *l l* is such that it is necessary to show it in *elevation,* the vertical shaft being dotted through both it and the collar *b*. We are here confronted by a new condition, because this collar, *b,* is finished on the upper side by a concave moulding, or fillet, by which its diameter is reduced to an exact equality with that of the hub of the lever *l l*. Were this view left simply as an outside view, or elevation, then it would be ambiguous, since the fillet line, *c c,* would leave it uncertain whether *l* and *b* were or were not separate pieces. This ambiguity is removed by a very simple expedient; having drawn the view as if in elevation, the two pieces, *l* and *b,* are "sectioned" in opposite directions; the sectioning lines are not to be *dotted,* but drawn in finely, regardless of the outlines of the elevation.

Finally, in order to show the form of the tapered pin which secures the loose collar to the shaft, there is given, below the side view, a top view of this pin, and of the loose collar, *b,* and of the shaft, as though the shaft were cut by a plane through *c c,* perpendicular to its axis. And by this selection and arrangement of views the whole combination is so clearly explained that it cannot be misunderstood.

The expedient of "sectioning" over the lines of an outside view is, in this particular case, introduced merely for the purpose of making clear the separation of one piece from another; but it will readily occur to the thoughtful reader that it may be employed with good effect in emphasizing the form of the section of a piece in which no actual ambiguity would result from its omission. But it is necessary to insist upon this, that on no account should the "sectioning lines" be *dotted,* notwithstanding the fact that the concealed outlines by which they are terminated are of necessity dotted in; the attempt to dot the section lines has often been made and as often has resulted in most lugubrious failure.

ENGINEERS' DICTIONARY.—XIX.

Gib—The *strap, gib* and *key* forms one of the methods of connecting the brasses for the bearing of a crank-pin to the connecting-rod, or in general for securing the brasses of any rotating pin joint connection to the rod or link. In Fig. 77 *AB* is the connecting rod, *CD* the brasses, and *EF* the strap. Through the rod and strap is a slot, as shown. *G* is the gib and *K* the key. The outer sides of the key and gib should be parallel and at right angles to the center line of the rod. The inner faces, which bear on each

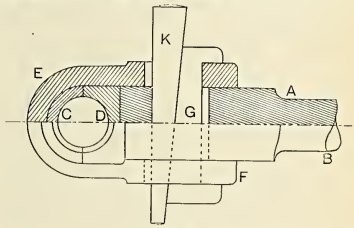

FIG. 77.

other, are inclined as shown. It is readily seen that with the key driven hard down the strap will be drawn over to the right, and the two brasses *CD* forced together to a bearing on the lines between them. Then as wear occurs and the pin becomes loose the lines may be thinned down and the key driven down further, until the brasses are again adjusted with the proper amount of clearance for smooth working. Similarly, if desired, the key can be backed up and the brasses loosened. The key is secured by a set-screw.

Girder-Brace—A form of brace used for supporting the top of the combustion chamber of a fire-tube boiler. They are known also as *crown-bars.* See under this term Fig. 41.

Gland—The part of a stuffing-box which is forced against the packing, thus compressing it and making

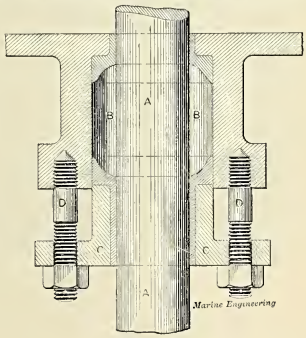

FIG. 78.

the joint tight. In Fig. 78, representing a stuffing-box, *CC* is the gland carried on the studs *D* and *D* and forced in by the nuts as shown. This compresses the packing within the space *B,* and the joint between the rod *A* and the packing is thus made tight.

NEW PUBLICATIONS.

ENGINE ROOM PRACTICE. A Hand-book for Young Marine Engineers. By John G. Liversidge, Chief Engineer, Royal Navy. London, Charles Griffin; Philadelphia, J. B. Lippincott Co. First Edition, 1899. Size 5 1-2 by 8. Pages 292, with many drawings and engravings. Cloth, $2.50.

This book is one of the very few in which marine practice is treated in the manner it deserves, and it fully realizes the hope of the author that it may be useful to young engineers who are preparing for or entering on their career, and also to those other officers whose work and responsibilities are so intimately connected with the machinery of a modern steamship. The author (Chief Engineer in the British Navy) has demonstrated that he is perfectly familiar with the practice in the merchant marine, and the book ought to be of interest to all classes of seafaring engineers. The author states that the practice described in his book will not be that which is in use in every case, and that perhaps it is unnecessary to disclaim any pretense of superiority for the methods described, but that they are merely those which have been successfully used in certain instances. One could hardly expect that the experience of any one man could cover all cases, as, for instance, in the chapter on repair work where machine shop facilities enter largely into the question, but the methods shown will give an engineer a good understanding of the plan of procedure. The book is entirely free from all formulas which would puzzle the minds of the non-technical. Furthermore, it treats of practice which is distinctly up-to-date and makes a specialty of the auxiliary machines, which are of such great importance nowadays and which are so uniformly neglected in most treatises on marine work.

The first chapter treats of the different types of main and auxiliary engines, advantages of twin screws, and tables of comparison in the advance of practice in the British Navy and several well-known steamship lines. Several chapters are then devoted to the condition of service of engineer officers, Royal Naval and Royal Naval Reserve, and in the leading steamship lines, size of crew, duties and routine of service.

The next chapter treats of raising steam, giving all the minute details, both in the engine room and boiler room, such as starting forced draft fans, trying steering gears and telegraphs and preparing the lubricating gear, manipulating the drains, etc. Then follows the duties of a steaming watch, both in the engine and boiler rooms, and a description of all the details that require attention and observation, followed by a chapter of instruction on shutting off steam. The details of harbor duties are then described, both for the navy and merchant marine, followed by an extremely interesting chapter on repairs and adjustment of machinery. The refitting, taking leads and adjustment of bearings are described, as well as different methods of taking machinery adrift and the handling of the parts, also advice as to where to look for wear in certain parts, adjustment of different styles of metallic packing and testing for leaks in the condensers, also all the work done in dry dock, such as grinding of valves, zinc protection and examination of outboard shafting.

The article on preservation and repairs of boilers is exceptionally good, as it goes into details as to the various methods of patching and repairing Scotch boilers, the method of dealing with cracks in plates, repairing and renewing leaky stays, and the handling of tubes and stay tubes.

The next chapter deals with the hull and its fittings, main drains from double bottoms, sluice and flooding valves and the methods of clearing, painting and preserving the hulls, double bottoms and bunkers, and the different paints, cement and compositions used.

Then follows a detail description of all the auxiliary machinery, beginning with the different well-known styles of pumps, their treatment, irregularities, and adjustments. Then the different styles of feed heaters, feed water regulators, and evaporators are shown. The running and care of the dynamos and electric engines is well described, also the hydraulic and air compressing machinery.

The chapter on refrigerating machinery covers the dry air, the carbonic anhydride, and the anhydrous ammonia refrigerators, describing their advantages, disadvantages and their treatment.

The last chapter deals with the description and handling of machinery and boilers of torpedo boat destroyers, and also instruction in the handling of Belleville water-tube boilers.

The appendix contains the requirement for the entry and the training of Assistant Engineers of the Royal Navy and examples of examination questions for the rank of engineer and chief engineer of the same service.

This book is well illustrated and the illustrations are easy to understand, and they bring out the points in question very distinctly. Although there are only a few types of American auxiliaries described, English and American marine practice are so closely allied that the dividing line can hardly be drawn, and with the exception of several auxiliary outfits which are not often seen on American vessels, but which are the same in principle, the American marine engineer will find the book well worthy of close study.

"Report of the Commissioners and a History of Lincoln Park, Chicago," is the title of a beautifully illustrated volume, which in artistic make-up, illustrations and typographical excellence is superior to anything of the sort that has ever come under our notice. Annual reports are not usually interesting documents, but in this instance the compiler, I. J. Bryan, Secretary to the Commissioners, has produced a document which is of the greatest interest. There is an extended reference to the great storm of October 25, 1898, on Lake Michigan, which did great damage to the Park beach and esplanades. An excellent series of protographs show the tremendous power of the waves even in these inland waters. Complete details of the beauties, both natural and acquired, of the Park are given, a free use being made of excellent half-tone illustrations. The Commissioners of Lincoln Park have shown fine enthusiasm in their work by the production of this report.

The September issue of *The Engineering Magazine*, New York, contains the second installment of the very interesting article on "The Development of German Shipbuilding," by Rudolph Haack. This installment, which is very handsomely illustrated, treats chiefly of the shipyards on the North-Sea coast.